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# Food Environment and Whole-Diet in Children — Studies on Parental Role Modelling and Food Availability

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# FOOD ENVIRONMENT AND WHOLE-DIET IN CHILDREN

## STUDIES ON PARENTAL ROLE MODELLING AND FOOD AVAILABILITY

**Henna Vepsäläinen**

ACADEMIC DISSERTATION

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# ABSTRACT

Since food behaviors are learned during childhood and may also track into adulthood, promoting healthy food habits among children and families is of special importance. Health promotion has traditionally been focused on individuals, but during the recent decades, the attention has shifted more and more towards environments. The food environment – a concept that encompasses physical, social, cultural, economic and political environmental factors associated with food behavior – is especially important for children, who cannot be considered to be fully responsible for their food choices. Arguably, home, preschool and school are the most prominent food environments for children.

It has been shown that parental food consumption and home food availability – the two most commonly used measures for food environment - are consistently associated with dietary behavior among children. However, most of the studies investigating parent-child dietary resemblance have focused on the consumption of single food groups, such as consumption of fruit and vegetables. Similarly, home food availability has mostly been measured unidimensionally: as the availability of a single food group or as healthy/unhealthy food availability. Additionally, the outcomes used in the studies have mostly been food groups or theory-based dietary indices. However, the use of data-driven dietary patterns may give a more realistic picture of the actual diets of the participants. Thus, this study aimed at investigating social and physical environmental factors associated with whole-diet among children.

This thesis used data from two cross-sectional studies. Papers I and II were based on data from the DAGIS study, which was conducted in 66 Finnish preschools and investigated health behaviors and associated factors. The participants were 864 children from the groups of 3–6-year-olds. Food consumption among the children and both parents was measured using a food frequency questionnaire (FFQ) filled in by the parents. The parents also reported home food availability and sociodemographic factors of the family. Paper III used data from the ISCOLE study, which examined obesity-related lifestyle and environmental factors among 9–11-year-olds in 12 study sites worldwide. Altogether 6560 children (54% girls) were included in the current analyses. The children reported their own food consumption, whereas the parents of the participating children reported home food availability. Detailed school audits were performed in all participating schools (n=256) to measure school food availability.

In paper I, parent-child dietary resemblance and associated sociodemographic factors were studied. A novel statistical method was used in order to compare

food consumption of the parent and that of the child on a whole-diet level. Based on the consumption frequency, the food items were ranked separately in the child's and the parents' FFQs. A dietary resemblance measure was calculated for each parent-child pair: a similar ranking in both the child's and the parent's FFQ yielded a resemblance measure of +1, whereas no resemblance in ranking resulted in the resemblance measure of 0. Father-child resemblance was on average 0.50 (95% CI, confidence interval 0.48–0.52), whereas mother-child resemblance was 0.57 (95% CI 0.55–0.58). However, having mother as a respondent (providing food consumption information on behalf of the child) was inversely associated with father-child resemblance, and a tendency for similar reporter-bias was also seen in the mother-child resemblance. Additionally, the number of weekly family meals was positively associated with mother-child dietary resemblance. Parental educational level was not associated with parent-child dietary resemblance.

In papers II and III, the availability of unhealthy foods in the home was positively associated with dietary patterns generally regarded as unhealthy. Although having healthy foods in the home was inversely associated with unhealthy dietary patterns, the abundance of unhealthy foods seemed to at least partly overrule this inverse relation. Respectively, the availability of healthy foods in the home was positively and that of unhealthy foods inversely associated with dietary patterns generally regarded as healthy. The results were similar both among preschoolers and school-aged children. School food availability was not associated with dietary patterns.

In conclusion, parent-child dietary resemblance was moderate regardless of the socio-economic background of the family. In addition, an important observation was made: the diet of the child resembled more the diet of the parent providing food consumption data on behalf of the child. Since the possible reporter-bias can affect the interpretation of the results, it would be advisable for researchers to report who filled in food consumption information for the child and take this into account in further analyses. Furthermore, in order to capture the social food environment more comprehensively, fathers – not only mothers - should be involved as parents in family-based studies. Additionally, since the availability of unhealthy foods in the home was associated with unhealthy eating regardless of the availability of healthy foods, the results suggest that it is particularly important to limit the availability of unhealthy foods in the home. The results of this study can be used in planning and carrying out health promotion programs aiming at improving the diets of the families.

# TIIVISTELMÄ (FINNISH ABSTRACT)

Ruokatottumukset kehittyvät lapsuudessa ja voivat myös säilyä aikuisuuteen. Siksi lasten ja perheiden kannustaminen terveellisiin ruokatottumuksiin on tärkeää. Terveydenedistämisessä on perinteisesti keskitytty yksilöihin, mutta viime vuosikymmeninä huomio on kiinnittynyt yhä enemmän ympäristöihin. Ruokaympäristöllä tarkoitetaan ruokakäyttäytymiseen liittyviä fyysisiä, sosiaalisia, kulttuurisia, taloudellisia ja poliittisia ympäristötekijöitä. Ruokaympäristöllä on erityinen merkitys lapsille, sillä heidän ei voida ajatella olevan täysin vastuussa omista ruokavalinnoistaan. Lapsen elämässä merkittävimpiä ruokaympäristöjä ovat koti, päiväkoti ja koulu.

On näyttöä siitä, että sekä vanhempien ruoankäyttö että kodin ruokasisustus – käytetyimmät ruokaympäristön mittarit – ovat johdonmukaisesti yhteydessä ruoankäyttöön lapsilla. Suurin osa tutkimuksista, jotka ovat selvittäneet vanhemman ja lapsen ruoankäytön samankaltaisuutta, on kuitenkin keskittynyt yksittäisen ruokaryhmän, kuten kasvisten ja hedelmien, käyttöön. Samoin ruokasisustusta on yleisimmin mitattu yksiulotteisesti yksittäisen ruokaryhmän tai terveellisten/epäterveellisten ruokien saatavuutena kotona. Lisäksi tutkimusten vasteina on useimmiten ollut ruoankäyttö ruokaryhmätasolla tai teoriapohjainen ruokavalioindeksi, vaikka aineistolähtöiset ruokavaliotyylit voisivat kuvata tutkittavien ruokavalioita totuudenmukaisemmin. Tämän tutkimuksen tavoitteena oli tutkia kokonaisruokavalioon liittyviä sosiaalisia ja fyysisiä ympäristötekijöitä lapsilla.

Tutkimuksen aineisto koostui kahdesta poikkileikkaustutkimuksesta. Julkaisuissa I ja II käytettiin aineistoa DAGIS-tutkimuksesta, joka tutki terveyskäyttäytymistä ja siihen liittyviä tekijöitä 66 suomalaisessa päiväkodissa. Tutkittavina oli 864 lasta 3–6-vuotiaiden ryhmistä. Lasten ja heidän vanhempiensa ruoankäyttöä mitattiin vanhempien täyttämällä ruokafrekvenssikyselyllä (FFQ, engl. food frequency questionnaire). Lisäksi vanhemmat raportoivat kodin ruokasisustuksesta sekä perheeseen liittyvistä sosiodemografisista tekijöistä. Julkaisussa III käytettiin aineistoa 12 maan ISCOLE-tutkimuksesta, joka tutki lihavuuteen liittyviä elintapoja ja ympäristötekijöitä 9–11-vuotiailla lapsilla. Analyyseissä oli mukana yhteensä 6560 lasta (54 % tyttöjä). Ruoankäyttöä mitattiin lasten täyttämällä FFQ:lla, ja lasten vanhemmat raportoivat kodin ruokasisustuksesta. Koulujen ruokasisustusta selvitettiin havainnoimalla kaikissa osallistuvissa kouluissa (n=256).

Julkaisussa I tutkittiin vanhemman ja lapsen ruoankäytön samankaltaisuutta ja siihen liittyviä sosiodemografisia tekijöitä. Kokonaisruokavalion samankaltaisuuden määrittämiseen käytettiin uudenlaista tilastollista menetelmää,

jossa sekä vanhemman että lapsen FFQ:n ruokarivit järjestettiin käyttötiheyden mukaan. Tämän jälkeen jokaiselle vanhempi-lapsi-parille laskettiin samankaltaisuutta kuvaava luku siten, että tismalleen sama ruokarivien järjestys lapsen ja vanhemman FFQ:ssa tuotti samankaltaisuudeksi +1. Jos ruokarivien järjestys lapsen FFQ:ssa ei muistuttanut lainkaan vanhemman vastaavaa, samankaltaisuudeksi saatiin 0. Isän ja lapsen välinen samankaltaisuus oli keskimäärin 0,50 (95 %:n luottamusväli 0,48–0,52), kun taas äidin lapsen välinen samankaltaisuus oli 0,57 (95 % luottamusväli 0,55–0,58). Jos äiti oli raportoinut lapsen ruoankäytön, isän ja lapsen välinen samankaltaisuus oli pienempi verrattuna tilanteeseen, jossa isä oli sijaisraportoijana. Myös äidin ja lapsen samankaltaisuudessa nähtiin viitteitä vastaavasta raportoijaan liittyvästä harhasta. Lisäksi viikoittaisten perheaterioiden määrä oli positiivisesti yhteydessä äidin ja lapsen ruokavalion samankaltaisuuteen. Vanhempien koulutustaso ei ollut yhteydessä vanhemman ja lapsen ruokavalion samankaltaisuuteen.

Julkaisuissa II ja III havaittiin, että epäterveellisten ruokien saatavuus kotona oli positiivisesti yhteydessä yleisesti epäterveellisinä pidettyihin ruokavaliotyyleihin. Vaikka terveellisten ruokien saatavuus kotona oli käänteisesti yhteydessä epäterveellisiin ruokavaliotyyleihin, vaikutti siltä, että yhteys ainakin osittain kumoutui, jos myös epäterveellisiä ruokia oli runsaasti saatavilla. Vastaavasti kodin terveellisten ruokien saatavuus oli positiivisesti ja epäterveellisten käänteisesti yhteydessä yleisesti terveellisinä pidettyihin ruokavaliotyyleihin. Tulokset olivat samanlaisia sekä päiväkoti- että kouluikäisillä lapsilla. Koulun ruokasisustus ei ollut yhteydessä ruokavaliotyyleihin.

Vanhemman ja lapsen ruokavaliot muistuttivat toisiaan kohtalaisesti riippumatta perheen sosioekonomisesta taustasta. Lisäksi tutkimuksessa tehtiin tärkeä havainto: lapsen ruokavalio muistutti enemmän sitä vanhempaa, joka oli raportoinut lapsen ruoankäytön tämän puolesta. Tällä mahdollisella sijaisraportoijaan liittyvällä harhalla voi olla vaikutusta tulosten tulkintaan. Siksi tutkijoiden tulisi aina raportoida, kuka toimi lapsen sijaisraportoijana, ja ottaa tämä huomioon analyyseissä. Äitien lisäksi myös isät tulee huomioida perheiden ruoankäyttötutkimuksissa, jolloin sosiaalinen ruokaympäristö kyetään kuvaamaan kokonaisvaltaisemmin. Koska epäterveellisten ruokien saatavuus oli yhteydessä epäterveelliseen syömiseen riippumatta terveellisten ruokien saatavuudesta, tutkimuksen tulokset painottavat epäterveellisten ruokien saatavuuden rajoittamista kotona. Tämän tutkimuksen tuloksia voidaan hyödyntää perheiden ruokavalion parantamiseen tähtäävien terveydenedistämiskampanjoiden suunnittelussa ja toteutuksessa.

# CONTENTS

# LIST OF ORIGINAL PUBLICATIONS

This thesis is based on the following publications:

I Vepsäläinen H, Nevalainen J, Fogelholm M, Korkalo L, Roos E, Ray C, Erkkola M. Like parent, like child? Dietary resemblance in families. Submitted.

II Vepsäläinen H, Korkalo L, Mikkilä V, Lehto R, Ray C, Nissinen K, Skaffari E, Fogelholm M, Koivusilta L, Roos E, Erkkola M. Dietary patterns and their associations with home food availability among Finnish pre-school children: a cross-sectional study. Public Health Nutrition 2018;21:1232–42.

III Vepsäläinen H, Mikkilä V, Erkkola M, Broyles ST, Chaput JP, Hu G, Kuriyan R, Kurpad A, Lambert EV, Maher C, Maia J, Matsudo V, Olds T, Onywera V, Sarmiento OL, Standage M, Tremblay MS, Tudor-Locke C, Zhao P, Church TS, Katzmarzyk PT, Fogelholm M. Association between home and school food environments and dietary patterns among 9–11-year-old children in 12 countries. International Journal of Obesity Supplements 2015;5 (Suppl 2):S66–73.

The publications are reprinted with the kind permission of their copyright holders and referred to in the text by their roman numerals. In addition, some unpublished results are presented.

# ABBREVIATIONS

| | |
|---|---|
| BMI | Body mass index |
| CI | Confidence interval |
| DAGIS | Increased Health and Wellbeing in Preschool -Study |
| DASH | Dietary Approaches to Stop Hypertension |
| FFQ | Food frequency questionnaire |
| HEI | Healthy Eating Index |
| ICC | Intra-class correlation coefficient |
| ISCOLE | International Study of Childhood Obesity, Lifestyle and the Environment |
| PCA | Principal component analysis |
| RRR | Reduced rank regression |
| SES | Socio-economic status |
| SSBs | Sugar-sweetened beverages |
| WHO | World Health Organization |
| WIC | Special Supplemental Nutrition Program for Women, Infants, and Children |

# 1 INTRODUCTION

Along other health behaviors, eating habits have generally improved in developed countries during the recent decades [1-3]. Favorable changes have also occurred in the diets of Finnish children: while the proportion of children consuming the recommended amount of vegetables, fruits and berries was low some ten years ago [4, 5], there are now signs that the tide might be turning [6]. However, there is still room for improvement. Since food behavior and prudent dietary habits (such as vegetable and fruit intake) are usually learned during childhood, and these habits may also track into adulthood [7-9], childhood is a crucial time to influence these behaviors, and interventions should target families.

Traditionally, health promotion programs have focused on individuals (their knowledge, skills, and attitudes) in order to modify their health behaviors [10]. Little by little, the significance of environmental factors on all levels – from nearby, tangible environments, such as the home environment, to more distal environments, such as legislation – has, however, received more attention. For example, the Commission on Ending Childhood Obesity, established in 2014 by the World Health Orgranization (WHO), concluded in their report that tackling childhood obesity requires a whole-of-government approach and consideration of the environmental context [11]. Their recommendations include, for instance, the creation of healthy food environments in settings such as schools and preschools and increasing access to healthy foods in disadvantaged communities.

The concept of food environments has not been all-inclusively defined. Townshend & Lake, for example, have defined the food environment broadly as any opportunity to obtain food [12]. However, food environment has also been conceptualized to include the availability and accessibility of food as well as food advertising and marketing [13, 14]. In other words, the food environment may also encompass - in addition to physical or built environmental factors - socio-cultural, economic and political factors [15]. The existence of the more distant dimensions of food environment have been acknowledged for instance by Swinburn et al., who have suggested that although individuals acting in obesogenic environments (i.e. environments that encourage weight gain and obesity) need to be supported, the focus should be in policies aiming at reversing the obesogenic nature of the environments [16]. The different dimensions of food environments are intertwined and manifest themselves in several locations, such as homes, preschools, schools, worksites and neighborhoods.

To this day, the importance of healthy food environments has been widely recognized. Numerous publications have suggested that obesogenic environment (e.g., an environment that encourages weight gain and obesity) may have influenced children's energy balance and thus led to the increase of obesity [17-20]. Regarding children, home, preschool and school environments are arguably the most prominent environmental determinants of eating behavior. However, to this day, most of the studies investigating food environments have focused on the consumption of single food groups, such fruit and vegetables, and not considered the whole diet. The social home food environment has mostly been measured as parental consumption, and the significance of mothers has possibly been overemphasized. Furthermore, the physical food environment has frequently been conceptualized as either healthy or unhealthy, although in reality, the food environments are more complex and may simultaneously contain traits of both dimensions, healthy and unhealthy.

This doctoral thesis aimed at investigating social and physical home and school environments as determinants of food behavior in children using an empirical whole-diet approach. The thesis consists of three papers, first of which examines the similarities in parental and child food consumption (social food environment), whereas the two latter papers investigate the associations between food availability (physical food environment) and dietary patterns.

# 2 FOOD ENVIRONMENT AND DIET AMONG CHILDREN

## 2.1 THE SOCIOECOLOGIC MODEL

The socioecologic model states that health behaviors, such as food behavior or physical activity, are affected not only by individual characteristics but also by the environments surrounding us [21]. These environmental factors form together with individual characteristics a complex and dynamic system in which the levels interact with each other. On an individual level, for instance, cognitions, skills and biological factors can influence food choice. As for environmental-level factors, family, friends and peers (social environment) as well as homes, schools and work sites (physical environment) may have an effect on food behavior. On a macro-level, policies, food marketing, social norms, pricing and taxation, just to name a few, can impact eating behavior both directly and indirectly. Traditionally, research has focused on individual characteristics as risk factors for health outcomes, such as childhood obesity [22] or food behavior, although a more holistic approach could probably target those risk factors more efficiently.

Children's food behavior is highly influenced by food environments [23]. Since children cannot be considered to be fully responsible for their food choices, the food environments are even more important for them as they are for adults. Systematic reviews have identified neighborhood environments as one of the possible determinants of food consumption among children [24-26]. However, the natural food environments in the life of a child revolve around home and school, and thus, home and school environments are worthy of more thorough investigation.

The food environment surrounding a child consists of social and physical environmental aspects (Figure 1). Social food environmental factors that have been shown to be related to dietary behaviors among children are, for example, parenting styles, parental eating behaviors, parental nutrition knowledge and family eating patterns as well as policies and practices implemented in schools, to mention but a few [27]. As for the physical food environment (often referred to as built and/or natural environment), the availability and accessibility of foods is one of the most used measures, and can be assessed both in the homes and in the schools as well as in for example recreational venues. In this thesis, the sub-studies focused on the social (paper I) and physical home environments (papers II and III) as well as the physical school environment (paper III).

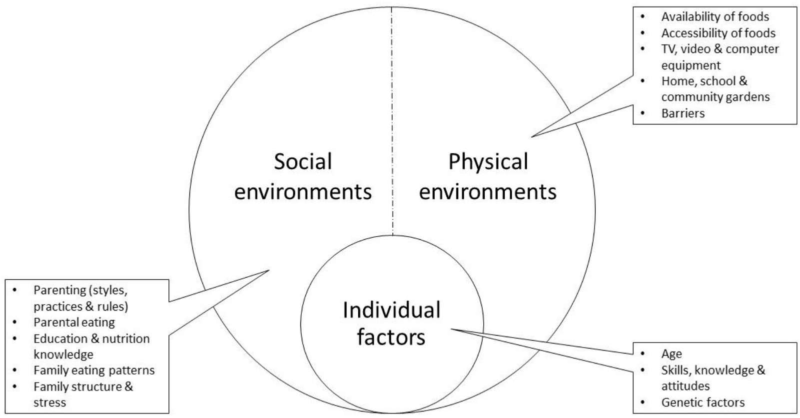


**Figure 1** The social and physical food environments (figure adapted from [21, 27]).

## 2.2 SOCIAL FOOD ENVIRONMENT AND DIET IN CHILDREN

In addition to controlling the availability and accessibility of foods (physical food environment), the parents can create social norms, offer social support and act as role models regarding healthy or unhealthy eating during family meals in the home (social food environment) [28]. Systematic reviews have shown that parental fruit and vegetable intake is consistently associated with children's fruit and vegetable consumption [29, 30]. Furthermore, it is widely believed that dietary intakes of parents and their children correlate strongly [31-34], although a meta-analysis conducted in 2011 yielded only weak or moderate associations varying across studies, nutrients or foods assessed, parent-child pairs in question, and dietary assessment methods used [35].

In order to identify studies that have assessed parent-child dietary similarity, a systematic literature search in the PubMed database was performed on November 24th, 2017. The search command used was: (similarity OR resemblance OR concordance) AND (food OR dietary) AND (family OR families OR children OR mother* OR father* OR parent* OR maternal* OR paternal*) and the search terms were restricted to title or abstract. The search was not restricted in terms of publication dates or article types. The search produced altogether 565 publications. Based on the titles and abstracts, 530 studies were excluded. The number of full text-articles assessed was 35. Additional 31 studies were identified from the reference lists of the identified full-text articles. Altogether 66 full-text articles were retrieved, of which 42 were further excluded. The reasons for exclusions were as follows: participating children were older than 13 years or younger than two years (n=23), did not measure parental or child food intake (n=11), was not available or was not written in English (n=8), was not observational (n=1). Thus, this literature review comprises of 24 studies. Figure NN presents the flow of papers.

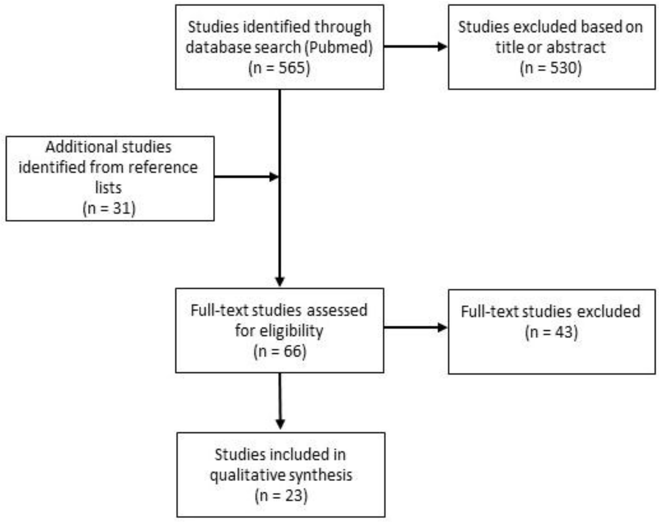


**Figure 2** The number of studies in each phase of the literature search

### 2.2.1 PARENT-CHILD DIETARY RESEMBLANCE

Altogether 23 observational studies were retrieved. The majority of the studies were conducted in the US (n=13), three in the UK and Australia and one in Finland and Belgium each. Two papers described dietary behavior in the same European sample with participants from Belgium, Cyprus, Estonia, Germany, Hungary, Italy, Spain and Sweden. Almost all of the studies (n=19) used cross-sectional design, whereas three studies were longitudinal and one was an intervention. Of the identified studies, ten examined mother-child similarities. Of the remaining studies, nine included both fathers and mothers as parents. However, in two of these studies, over 80% of the parents were mothers. Father-child similarity was investigated in two studies, and the two remaining studies did not specify if the parents were mothers, fathers or both. The studies are presented in more detail in Tables 1–3. The following subchapters present the studies investigating parent-child similarities in nutrient intakes, food consumption and whole diet. Since many of the studies investigated similarity on several levels, the same studies may come up on several subchapters.

#### 2.2.1.1 Nutrient intakes

<u>*Energy and macro-nutrient intakes*</u>

Similarities in energy-, macro- or micronutrient intakes were investigated in nine studies, which are presented in more detail in Table 1. Energy intake was examined in seven studies, two of which reported a positive parent-child correlation in energy intake [36, 37]. However, studies that had only mothers or fathers as parents or showed results separately for mothers and fathers showed inconsistent results [38-42]. One study suggested a negative correlation between African American mothers and their sons, whereas mother-daughter correlations were positive [40]. This observation was, however, not confirmed by other US or European studies [36-38].

Regarding fat intake, the reported parent-child similarities were inconsistent. Four studies reported weak positive parent-child, mother-child or father-child correlations ranging from 0.21 to 0.40 [37, 38, 42, 43]. However, four studies also reported no correlation in fat intake between mothers or fathers and their children [38-40, 42]. In one study, unadjusted fat intake, but not fat intake adjusted for total energy, correlated weakly between parents and their children [36]. Some studies suggested that the resemblance in fat intake might differ according to sex or BMI of the child [40, 43], which could at least partly explain the inconsistent findings. Other possible explanations are, for instance, differences in dietary assessment methods and energy adjustments or age of the participating children.

Altogether five studies investigated the quality of fat in the diet of the families [36, 38, 39, 42, 44]. The intake of saturated fat correlated positively between parents and their children in one study, but after adjusting for total energy, no association was detected [36]. Two studies reported a positive father-child correlation in saturated fat intake measured as E% [38, 42]. Interestingly, children's food consumption in these studies was reported by their mothers. However, also null associations have been reported [39]. Respectively, mother-child correlations in saturated fat E% have been reported to be either positive [38] or non-existent [42].

Four studies investigated similarities in carbohydrate intake adjusted for total energy intake [37-39, 42]. In a large European sample, parent-child correlation in carbohydrate intake measured as E% was weak but significant [37], whereas in a sample of 50 father-child dyads, no correlation in carbohydrate intake measured as E% was found [39]. Studies reporting both father-child and mother-child correlations came to the opposite conclusions: father-child correlation in carbohydrate intake was significant in an Australian sample [42], but not among US families in the Framingham Children's Study [38]. Respectively, the US study reported a weak mother-child correlation [38], whereas in the Australian sample, no such correlation was detected [42]. There are at least three reasons that may explain the opposite findings. First of all, there were only 28 father-child dyads in the Australian study, whereas the US study included 83 father-child dyads. Secondly, the two studies used different energy adjustment methods (E% vs. Willett's method). Third, the US study was conducted over 20 years earlier than the Australian study. It is possible, that changes for example in the family structure and society in general have affected parent-child similarities.

Considering protein intake, the reported parent-child and mother-child similarities were significant [37, 38, 42]. Father-child similarity was significant in the Framingham Children's Study [38], whereas two Australian studies reported no association between father's and child's protein intake measured in E% [39, 42]. The reasons discussed earlier (differences in sample size, different methods for energy adjustment and time between the studies) may explain these inconsistencies.

Parent-child similarities in fiber intake were examined in five studies [36, 39, 40, 42, 43]. Only two studies reported significant similarities: parent-child correlation was 0.26 in a large US sample [36], whereas mother-child correlation was 0.27 in a considerably smaller Australian sample. No association in fiber intake was reported both among Australian father-child [39, 42] and US mother-child dyads [40, 43]. However, only one study assessed fiber intake using 24h recall [36], whereas in the other studies, dietary intake was assessed using FFQs, which may not be able to capture all the sources of dietary fiber. Additionally, one of the studies [42] reported fiber intake as g/1000 kJ, that is, adjusted for energy intake, whereas the majority of the studies used g/d [36, 39, 40]. One study used a fiber intake score, the details of which were not reported [43]. The differences in the dietary assessment methods may explain the obscure results related to parent-child similarities in fiber intake.

_Micronutrient intakes_

In addition to parent-child similarities in energy or macronutrient intake, five studies went into more detail and investigated similarities in micronutrient intakes [36, 38-40, 44]. In a large US sample, parent-child similarity in sodium intake correlated significantly [36]. However, the study did not adjust for total energy intake. A significant correlation was also detected in two other US studies: Vollmer et al. reported a significant father-child association in sodium intake [44], whereas Oliveria et al. found a significant mother-child correlation in sodium intake [38]. The study by Oliveria et al. was the only study using sodium intake adjusted with total energy. No father-child correlation in sodium intake was observed in an Australian sample [39]. Due to recall bias, incomplete reporting and deficiencies in food composition databases, sodium intake is, nevertheless, challenging to assess accurately. In addition, there are multiple sources of sodium in one's diet. Thus, it is hard to judge if the similarities in sodium intake are due to the parents and their children actually eating similar foods.

Altogether four studies examined parent-child similarities in calcium intakes [36, 38-40]. Father-child correlations were non-significant in two studies [38, 39]. Beydoun et al. reported a significant parent-child correlation in calcium intake in a US sample [36]. Interestingly, in this large study sample, mother-child correlations were stronger compared to their father-child counterparts. However, mother-son and mother-daughter correlations were similar, unlike in a study of African American mother and children, in which mother-son correlation in calcium intake was borderline significantly negative while mother-daughter correlation was borderline significantly positive [40]. Since dairy products are a common source of calcium, a corresponding similarity could also be hypothesized to be seen in dairy product intake. Unfortunately, only one of the studies referred here also investigated similarities in dairy product consumption, and in this US sample, a similar pattern of a stronger mother-child correlation was also detected in dairy consumption [36].

Regarding similarities in the intake of other micronutrients, an Australian study reported significant father-child correlations in iron and vitamin C, but not in beta carotene intakes [39]. In this sample of 50 father-child dyads, a significant correlation in total fruit intake – a source of vitamin C - was also observed. Since some of the studies discussed in this literature review examined micronutrient intakes not adjusted with total energy, whereas other had used different energy adjustment methods, the results must be interpreted with caution. Furthermore, since micronutrients are usually obtained from multiple sources, it must be kept in mind that a strong resemblance in the intake of a certain nutrient does not necessarily mean that the actual food behavior of parents and their children is alike.

**Table 1.** *Details of the studies reporting parent-child similarities in energy, macro- or micronutrient intakes*

| First author, publication year, country | Age of the children; ethnicity; number of participants in the analyses | Dietary assessment method (parents) | Dietary assessment method (children), informant | Correlation coefficient or equivalent unless otherwise stated |
|---|---|---|---|---|
| Beydoun, 2009, USA [36] | 2–18-year-olds; non-Hispanic White, non-Hispanic Black, Hispanic, other; 4244 parent-child dyads | 2 x 24h recall | 2 x 24h recall, proxy response among 2–9-year-olds | Energy: PC 0.22*<br>Fat: PC 0.24*<br>Fat E%: PC 0.01<br>Saturated fat: PC 0.23*<br>Saturated fat E%: PC 0.02<br>Fiber: PC 0.26*<br>Sodium: PC 0.21*<br>Calcium: PC 0.20* |
| Bogl, 2017, Belgium, Cyprus, Estonia, Germany, Hungary, Italy, Spain & Sweden [37] | 2–10-year-olds; 996 parent-child dyads | 24h recall | 24h recall, children under 11 years were advised to ask their parents for help | Energy: PC 0.13*<br>Fat E%: PC 0.21*<br>Carbohydrates E%: PC 0.18*<br>Protein E%: PC 0.25* |
| Hall, 2011, Australia [39] | 5–12-year-olds; predominantly White; 50 father-child dyads | FFQ, 74 items | FFQ, 135 items, mother-reported | Energy: FC 0.17<br>Fat E%: FC 0.07<br>Saturated fat E%: FC 0.25<br>Carbohydrates E%: FC 0.01<br>Protein E%: FC 0.11<br>Fiber: FC 0.20<br>Sodium: FC 0.17<br>Calcium: FC 0.26<br>Iron: FC 0.29* |

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| | | | | Vitamin C: FC 0.34*<br>Beta carotene: FC 0.18 |
| Oliveria, 1992, USA [38] | 3–5-year-olds; 83 father-child dyads and 87 mother-child dyads | 2–4 x 3-day food record | 2–4 x 3-day food record, most of the records completed by the mother | Energy: FC 0.16, MC 0.17<br>Fat[†]: FC 0.15, MC 0.46*<br>Saturated fat[a]: FC 0.34*, MC 0.48*<br>Carbohydrates[a]: FC 0.18, MC 0.37*<br>Protein[a]: FC 0.34*, MC 0.29*<br>Sodium[a]: FC 0.18, MC 0.30*<br>Calcium[a]: FC 0.21, MC 0.29* |
| Robinson, 2014, Australia [42] | 8–12-year-olds; 28 father-child dyads and 64 mother-child dyads | FFQ | FFQ, self-report | Energy: FC 0.28, MC 0.27*<br>Fat E%: FC 0.40*, MC 0.06<br>Saturated fat E%: FC 0.46*, MC 0.11<br>Carbohydrates E%: FC 0.40*, MC 0.13<br>Protein E%: FC 0.22, MC 0.27*<br>Fiber[b]: FC 0.01, MC 0.27* |
| Stanton, 2003, USA [43] | 6th graders; White, African American; 404 mother-child dyads | FFQ, 35 items | FFQ, 35 items, self-report | Fat intake score: MC 0.22*<br>Fiber intake score: MC 0.06 |
| Vollmer, 2015, USA [44] | 3–5-year-olds; White, Black / African American, Asian / Asian American, Other; 150 father-child dyads | 24h recall | 24h recall, father-reported, weekend day or a day that the father was involved with feeding the child | Fatty acids ratio[c]: FC 0.19<br>Protein[d]: FC 0.09*<br>Sodium[d]: FC 0.24* |
| Wang, 2009, USA [40] | 10–14-year-olds; African American; 121 mother-child dyads | FFQ, 180 items | FFQ, 152 items, self-report | Energy: MC 0.04<br>Fat: MC 0.07<br>Fat E%: MC 0.16<br>Fiber: MC 0.02 |

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|---|---|---|---|---|
| | | | | Calcium: MC 0.02 |
| Wroten, 2012, USA [41] | 2–5-year-olds; African American, Hispanic American, White; 650 mother-child dyads | 24h recall | 24h recall, mother-reported | Energy: MC 0.48* |

PC=parent-child similarity, FC=father-child similarity, MC=mother-child similarity, *=p value ≤0.05, [a]energy-adjusted with Willett's method, [b]g/1000 kJ, [c]as part of the Healthy Eating Index: (PUFAs+MUFAs)/SFAs [45], [d]as part of the Healthy Eating Index g/1000 kcal [45]

#### 2.2.1.2 Food consumption

Altogether 17 of the identified 23 studies investigated parent-child similarity in food consumption. The studies are presented in more detail in Table 2. Most of the studies focused on fruit and vegetable consumption, but also sweet and savory snack as well as soft drink consumption were examined. Cross-sectional design was the most used, but also longitudinal observational studies and intervention studies have been conducted. The following subchapters describe the parent-child similarities in food consumption.

*Fruit and vegetable consumption*

Similarities in fruit and/or vegetable intake was investigated in 11 cross-sectional studies. Studies that did not differentiate between mothers and fathers reported only positive parent-child correlations in fruit and vegetable, fruit or vegetable intakes [36, 37, 46-48]. Fruit intake seemed to constantly correlate between mothers and children [41, 42, 49, 50] as well as between fathers and children [39, 42, 44]. Only one study reported non-correlating fruit and vegetable intakes between mothers and children, but among normal-weight mothers the correlation coefficient was statistically significant [40] suggesting that the association might be dependent on parental characteristics. Regarding vegetable intake, the results were less consistent: more non-significant associations in parent-child vegetable consumption were reported [39, 42, 49, 50] compared to significant associations [41, 42, 44].

Two studies were conducted in a longitudinal design. In a US study, mothers' fruit and vegetable intake was measured when their daughters were seven years [51]. The mothers' fruit and vegetable intake at baseline was positively associated with their daughters' fruit and vegetable intake two years later. In a Belgian study, similar results were obtained: mother's fruit and vegetable consumption in 2002 was positively associated with their children's fruit and vegetable consumption in 2005 [52]. In an obesity treatment study, change in parents' fruit and vegetable consumption was positively associated with change in children's fruit and vegetable consumption [53]. However, since the participants in the intervention study were primarily overweight or obese, the results may not necessarily be generalizable to normal-weight population.

*Sweets, snack and non-core food consumption*

Two studies that did not differentiate between mothers and fathers reported a positive correlation in the consumption of sugar, sweets and/or candies between parents and children [36, 37]. Mother-child and father-child correlations in sweets and/or chocolate consumption were inconsistent across studies: more non-significant correlations were reported [39, 49, 50] compared to positive correlations [41, 49]. These inconsistent findings are probably at least partly due to differences in dietary assessment methods (24h recall, food record or FFQ). Another explanation might be that the studies may have included different foods when grouping the food consumption variables. Furthermore, parents can restrict their children's sweets consumption differently from their own, which might also explain the inconsistent results.

In two studies, a positive correlation between parents and children was detected in high-fat food (fried foods, cheese, butter, cakes, cookies etc.) [47] or snack food (cookies, cakes, chips, candy etc.) [48] consumption. Mother-child correlations in non-core food, chips and snacks consumption were mostly positive [41, 42, 49]: only one study reported no correlation between mothers and their children in consumption of fried food or snacks [40]. Positive father-child correlations were detected in the consumption of 'empty calories' (solid fats, alcohol and added sugar, as part of the HEI) [44] and chips and cookies [39]. An Australian study reported no father-child correlation in the consumption of non-core foods (soft drinks, sweets and energy-dense, nutrient-poor food) [42]. However, the food items included the food groups in question were somewhat different in the studies making their comparison challenging. The consumption of fats and oils correlated positively between parents and children in one study [37], whereas in another study no such correlation was found [49].

In a Belgian longitudinal study, mothers' consumption of 'excess foods' (summed consumption of regular soft drinks, sweets and crisps) in 2002 was positively associated with their children's consumption of excess foods three years later [52]. This is particularly interesting, since the final model was adjusted for the child's baseline consumption suggesting that maternal change in consumption might affect food consumption of the child. In a UK study, maternal, but not paternal, non-core food consumption (a combination of foods with high energy content, such as biscuits, sweetened drinks, bacon, sausages, crisps and margarine) was positively associated with the child's non-core food consumption seven years later [54]. In the latter study, however, the food items included in the non-core food category were extremely diverse and can relate to different situations. Thus, the interpretation of these results is not straightforward.

In a study describing the results of a weight management intervention, change in parental consumption of nutrient-poor, energy-dense foods (>5g fat per serving, cereals with ≥25% of energy from fat or ≥30% of energy from sugar and non-nutritive foods of any kind) was positively associated with change in the child's consumption of those foods in a primarily overweight or obese population [53]. However, it is possible that the parallel changes in the parents' and children's diet were due to the intervention, and would have happened also without the other.

*Soft drink, milk and dairy consumption*

Six studies investigated parent-child similarities in milk and/or dairy consumption. Milk and/or dairy consumption was positively correlated among parents and children in three studies [36, 37, 48]. Furthermore, a significantly stronger mother-child correlation in dairy consumption compared to father-child correlation was reported in a large US sample [36]. Mothers' dairy consumption was positively associated with that of their children in two studies [42, 49]. A positive father-child correlation in dairy consumption was detected in one study [42], whereas one study reported no such association [44]. However, the final aim in the latter study was to investigate similarities in HEI, and thus, the father-child associations in the individual components of HEI must be interpreted with caution.

In a US sample, a positive correlation in soft drink consumption between parents and children was detected [36]. Similarly, another US study reported that children whose parents drank soft drinks regularly were more likely to consume soft drinks five or more times per week [55]. However, the parents in the latter study did not report their own soft drink consumption. Thus, the study did not actually measure parental soft drink consumption, but rather the children's perception of their parents' soft drink consumption. Furthermore, not all studies have confirmed the positive association in soft drink consumption: two US studies found no association between parental consumption of sweetened beverages and their consumption among children [40, 48]. In addition, no such correlation in soft drink consumption between mothers and children was found in a UK study [49].

*Cereal products, meat and vegetarian protein consumption*

Four studies investigated similarities in the consumption of cereals and/or cereal products. A large European study found positive parent-child correlation in the consumption of healthy and unhealthy cereals [37]. In two studies, a positive correlation in the consumption of grains [42] or bread [49] was detected, whereas mother-child correlation in the consumption of breakfast cereals was non-significant in one study [49]. The consumption of grains (in total, whole grains or refined grains) correlated positively between fathers and children in two studies [42, 44].

The consumption of healthy and unhealthy meat and meat products correlated positively between European parents and their children in one study [37].

However, the mother-child correlations in consumption of unhealthy meat products were stronger than the corresponding father-child correlations. Among Australian families, positive mother- and father-child correlations in the consumption of meat were detected [42]. However, in a UK sample meat consumption did not correlate between mothers and children [49]. Furthermore, in an Australian study, no association between fathers' and children's total protein intake was reported [44].

In the IDEFICS study, the consumption of healthy meat alternatives (for example soy products, meat and dairy substitutes) correlated positively between parents and children, but the correlations differed between parent-child dyads [37]. In a UK study, mother-child correlation in the consumption of baked beans was positive [49], whereas in an Australian study, both mother- and father-child correlations in the consumption of vegetarian protein sources were non-significant [42]. The consumption of plant and seafood protein correlated between fathers and their children in an Australian study [44]. Mother-child correlation in fish consumption was non-significant in one study [49].

**Table 2.** *Details of the studies reporting parent-child similarities in food consumption*

| Cross-sectional studies | | | | |
|---|---|---|---|---|
| **First author, publication year, country** | **Age of the children; ethnicity; number of participants in the analyses** | **Dietary assessment method (parents)** | **Dietary assessment method (children), informant** | **Correlation coefficient or equivalent unless otherwise stated** |
| Beydoun, 2009, USA [36] | 2–18-year-olds; non-Hispanic White, non-Hispanic Black, Hispanic, other; 4244 parent-child dyads | 2 x 24h recall | 2 x 24h recall, proxy response among 2–9-year-olds | Fruits and vegetables: PC 0.29*<br>Sugar and candies: PC 0.21*<br>Dairy products: PC 0.17*<br>Soft drinks: PC 0.0.16*<br>Unsweetened soft drinks: PC 0.17* |
| Bogl, 2017, Belgium, Cyprus, Estonia, Germany, Hungary, Italy, Spain & Sweden [37] | 2–10-year-olds; 996 parent-child dyads | 24h recall | 24h recall, children under 11 years were advised to ask their parents for help | Fruits and vegetables: PC 0.38*<br>Sugar and sweets: PC 0.22*<br>Healthy fat and oils: PC 0.31*<br>Unhealthy fat and oils: PC 0.25*<br>Healthy milk and dairy products: PC 0.28*<br>Unhealthy milk and dairy products: PC 0.12*<br>Healthy cereals and cereal products: PC 0.36*<br>Unhealthy cereals and cereal products: PC 0.22*<br>Healthy meat and meat products: PC 0.23*<br>Healthy meat alternatives: PC 0.26*<br>Unhealthy meat and meat products: PC 0.20* |
| Fisher, 2002, USA [46] | 4–6-year-old girls; non-Hispanic; 191 parent-child dyads | FFQ | 3 x 24 h recall, mother-reported in the presence of the child | Fruits and vegetables: PC 0.23*[a] |

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| Gibson, 1998, UK [50] | 9–11-year-olds; White, Afro Caribbean, other; 92 mother-child dyads | FFQ, 130 items | 3-day food record, self-reported with help from parents | Fruit intake: MC 0.36*<br>Vegetable intake: MC 0.00<br>Confectionary[b] intake: MC 0.09 |
| Grimm, 2004, USA [55] | 8–13-year-olds; 551 children | One question, child-reported | One question, self-reported | Soft drink consumption: Children whose parents drank soft drinks regularly had increased odds for consuming soft drinks five or more times per week |
| Hall, 2011, Australia [39] | 5–12-year-olds; predominantly White; 50 father-child dyads | FFQ, 74 items | FFQ, 135 items, mother-reported | Fruit: FC 0.35*<br>Vegetables: FC 0.18<br>Chocolate: FC 0.05<br>Cookies: FC 0.54*<br>Ice cream: FC 0.20<br>French fries: FC 0.0.15<br>Chips: FC 0.33* |
| Hannon, 2003, USA [47] | 5–12-year-olds; Asian American or Pacific Islander, African American, Hispanic, American Indian or Alaskan Native, White, Multiethnic; 283 adult-child dyads | FFQ, 36 items | FFQ, estimated by the family food provider | Fruit and vegetable consumption: statistically significant positive association<br>Fat consumption frequency: statistically significant positive association |
| Longbottom, 2002, UK [49] | 5–8-year-olds; 36 mother-child dyads | 4-day food record | 4-day food record, mother-reported | Fruits: MC 0.74*<br>Vegetables: MC 0.21<br>Chocolate confectionary: MC 0.37*<br>Sugar confectionary: MC 0.21<br>Chips: MC 0.65*<br>Savory snacks: MC 0.39*<br>Fats and oils: MC 0.24 |

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| | | | | Soft drinks: MC 0.19<br>Carbonated drinks: MC 0.53*<br>Milk and milk products: MC 0.34*<br>Breakfast cereals: MC 0.11<br>Bread: MC 0.36*<br>Fish: MC 0.15<br>Meat and meat products: MC 0.21<br>Baked beans: MC 0.34* |
| Raynor, 2011, USA [48] | 4–9-year-olds; White, African American, Hispanic or Latino, other; 135 parent-child dyads | 3-day food record | 3-day food record, parent-completed (93% of the parents were mothers) | Fruits: PC 0.04*[c]<br>Vegetables: PC 0.05*[c]<br>Low-fat dairy: PC 0.17*[c]<br>Snack foods: PC 0.03*[c]<br>Sweetened beverages: PC 0.07*[c,d] |
| Robinson, 2014, Australia [42] | 8–12-year-olds; 28 father-child dyads and 64 mother-child dyads | FFQ | FFQ, self-report | Fruits: FC 0.52*, MC 0.47*<br>Vegetables: FC 0.33, MC 0.40*<br>Core foods[e] E%: FC 0.28, MC 0.44*<br>Non-core foods[f] E%: FC 0.29, MC 0.44*<br>Dairy: FC 0.29, MC 0.32*<br>Grains: FC 0.49*, MC 0.35*<br>Meat: FC 0.24, MC 0.46*<br>Vegetarian protein sources: FC 0.31, MC 0.18 |
| Vollmer, 2015, USA [44] | 3–5-year-olds; White, Black / African American, Asian / Asian American, Other; 150 father-child dyads | 24h recall | 24h recall, father-reported, weekend day or a day that the father was involved with feeding the child | Fruits[g]: FC 0.18*<br>Vegetables[g]: FC 0.29*<br>Empty calories[g,h]: FC 0.24*<br>Dairy[g]: FC 0.00<br>Whole grains[g]: FC 0.28*<br>Refined grains[g]: FC 0.32* |

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| | | | | Plant/seafood protein[g,i]: FC 0.23* |
| Wang, 2009, USA [40] | 10–14-year-olds; African American; 121 mother-child dyads | FFQ, 180 items | FFQ, 152 items, self-report | Fruits and vegetables: MC 0.14<br>Fried food: MC 0.07<br>Snack: MC 0.07<br>Sweetened beverages: MC -0.05 |
| Wroten, 2012, USA [41] | 2–5-year-olds; African American, Hispanic American, White; 650 mother-child dyads | 24h recall | 24h recall, mother-reported | Fruits: MC 0.36*<br>Vegetables: MC 0.48*<br>Sweets[j]: MC 0.35*<br>Snacks[k]: MC 0.34* |
| **Longitudinal studies** | | | | |
| **First author, publication year, country** | **Age of the children; ethnicity; number of participants in the analyses** | **Dietary assessment method (parents)** | **Dietary assessment method (children), informant** | **Correlation coefficient or equivalent unless otherwise stated** |
| Gallloway, 2005, USA [51] | 9-year-old girls; non-Hispanic; 173 mother-child dyads | FFQ + 3 x 24h recall, completed when children at age 7 | 3 x 24 h recall at age 9, completed with help from the mother | Fruit and vegetables: MC: 0.36*[a] |
| Johnson, 2011, UK [54] | 11-year-olds; 342 children (twins), 121 mothers and 110 fathers | FFQ, 130 items, completed when children at age 4 | FFQ, 45 items, mother-reported | Core foods[l]: FC 0.07[m], MC 0.14*[m]<br>Non-core foods[n]: FC: 0.03[m], MC 0.08*[m] |
| Vereecken, 2010, Belgium [52] | 12–14-year-olds; 639 mother-child dyads | FFQ, completed when children at age 9–11 | FFQ, self-reported | Fruit and vegetables: MC 0.12*[o]<br>Excess food score[p]: MC 0.10*[o] |

**Intervention studies**

| First author, publication year, country | Age of the children; ethnicity; number of participants in the analyses | Dietary assessment method (parents) | Dietary assessment method (children), informant | Correlation coefficient or equivalent unless otherwise stated |
|---|---|---|---|---|
| Best, 2016, USA [53] | 7–12-year-olds; White, non-Hispanic; 148 parent-child dyads | 4-day food record | 4-day food record, self-reported | Nutrient-poor, energy-dense foods[q]: PC 0.47*<br>Fruits and vegetables: PC 0.26* |

PC=parent-child similarity, FC=father-child similarity, MC=mother-child similarity, *p value ≤0.05, [a]path coefficient from a structural equation model, [b]sweets and sweet biscuits including chocolate, [c]incremental variance accounted for by parental intake in a hierarchical regression model, [d]the model not statistically significant, [e]fruit (including dried fruit and fruit juice), vegetables, dairy, breads and cereals, meats and other protein sources, [f]soft drinks, sweets and energy-dense, nutrient-poor food, [g]as part of the Healthy Eating Index g/1000 kcal [45], [h]energy from solid fats, alcohol and added sugar, [i]seafood, nuts, seeds, soy products (other than beverages), beans and peas, [j]cakes, cookies, pies, pastries, snack bars etc., [k]crackers, chips, popcorn, fruit-, vegetable and meat-based savory snacks, [l]bread, cereals, rice, pasta and noodles; vegetables; fruits; dairy products; meat and fish, [m]estimate from basic model (univariate), [n]foods that can not be categorized to core foods, [o]beta estimate from a multivariate regression model adjusted with several variables, [p]soft drinks, sweet and savory snacks, [q]foods including >5g of fat per serving; cereal with ≥25% of energy from fat or ≥30% of energy from sugar; and non-nutritive foods of any kind regardless of fat, sugar or energy content

## *Whole diet*

Altogether six studies examined parent-child dietary resemblance on a whole-diet level taking into account not only single foods or food groups but a wider range of foods (Table 3). Three of the studies used predefined, theory-based dietary indices, such as the revised USDA 2005 Healthy Eating Index ($HEI_n$) [56], a more recent version of the HEI [45] or the Australian Child and Adolescent Recommended Food Score (ACARF) [57] and Australian Recommended Food Score (ARFS) [58]. These indices have been shown to be associated with health-related outcomes, and can thus be used as a measure of dietary quality. In three studies, data-driven approaches with no prior knowledge about the possible associations with health outcomes were used.

In a large US study, a positive parent-child correlation in $HEI_n$ was detected [36]. However, mother-daughter correlation was significantly weaker compared to mother-son and father-child correlations. Another US study investigating children of Mexican-origin also reported a positive mother-child association in HEI [59]. The latter study did not stratify the results based on the gender of the child. Among Australian families, both mother-child and father-child dietary quality as measured with ARFS and ACARF correlated significantly [42].

Three studies used data-driven approaches to investigate parent-child similarities in diets or health behaviors in general. In the I.Family cohort, three dietary clusters were identified: 'Sweet and fat', 'Refined cereals' and 'Animal products' [60]. In this sample of 1662 mother-child dyads and 789 father-child dyads, the mothers and children shared all three dietary clusters, whereas fathers and children seemed to share the 'Sweet and fat' pattern. However, the relatively small number of father-child dyads compared to mother-child dyads can, at least partly, explain these results.

Cluster analysis was also used in a study by Ovaskainen et al. [61]. In this sample of Finnish mother-child dyads, the children whose mothers' diets could be generally described as healthy (mothers in clusters named 'Fat-conscious' or 'Modern, healthy') were more likely allocated to a cluster generally regarded as healthy ('Healthy, low-fat'). Respectively, mothers with unhealthy dietary habits (clusters labeled 'Fast food, plenty' or 'Refined, sugar and butter') had children less likely in the 'Healthy, low-fat' cluster. Mothers whose dietary habits could be described as unhealthy (mothers in clusters named 'Fast food, plenty' or 'Refined, sugar and butter') had children with unhealthy dietary habits (cluster named 'Fast food, sweet'). However, the familial dependence on dietary clusters was only observed among 6-year-olds and their mothers – not in younger children. Although this is an interesting study with a large sample size, the number of the dietary clusters makes the results quite challenging to comprehend. However, it seems that based on this study, mothers and their

**Table 3.** *Details of the studies reporting parent-child similarities in food consumption*

| First author, publication year, country | Age of the children; ethnicity; number of participants in the analyses | Dietary assessment method (parents) | Dietary assessment method (children), informant | Whole diet measurement | Main results |
|---|---|---|---|---|---|
| Beydoun, 2009, USA [36] | 2–18-year-olds; non-Hispanic White, non-Hispanic Black, Hispanic, other; 4244 parent-child dyads | 2 x 24h recall | 2 x 24h recall, proxy response among 2–9-year-olds | $HEI_n$ | $HEI_n$ correlated between parents and their children (r=0.26), mother-daughter similarity significantly weaker compared to other parent-child dyads |
| Cameron, 2011, Australia [62] | 5–12-year-olds; 304 mother-child dyads | FFQ | FFQ | Cluster analysis | Mothers with healthy lifestyles had children with healthy lifestyles and vice versa |
| Dondero, 2016, USA [59] | 2–15-year-olds; Mexican-origin; 2090 mother-child dyads | Not specified | 24h recall, proxy response among 2–5-year-olds, assisted for 6–11-year-olds | HEI | Mother's HEI was positively associated with the child's HEI |
| Hebestreit, 2017, Belgium, Estonia, Cyprus, Germany, Hungary, Italy, Spain & Sweden [60] | 6–16-year-olds; 1662 mother-child dyads and 789 father-child dyads | 24h recall | 24h recall, children under 11 years were advised to ask their parents for help | Cluster analysis | Mothers and children shared all the three dietary patterns identified; fathers and children shared the 'sweet and fat' pattern |
| Robinson, 2014, Australia [42] | 8–12-year-olds; 28 father-child dyads and 64 mother-child dyads | FFQ | FFQ, self-report | ACARFS & ARFS | Diet quality indices correlated between fathers and their children (r=0.50) as well as between |

| | | | | | |
|---|---|---|---|---|---|
| | | | | | mothers and their children (r=0.55) |
| Ovaskainen, 2009, Finland [61] | 1-, 3- and 6-year-olds; 2134 mother-child dyads | FFQ, 181 items | 3-day food record, mother-reported | Cluster analysis | Familial dependence on dietary clusters was observed among 6-year-olds and their mothers |

$HEI_n$=The revised USDA 2005 Healthy Eating Index [56] , HEI=The Healthy Eating Index [45], ACARFS=Australian Child and Adolescent Recommended Food Score [57], ARFS=Australian Recommended Food Score [58] children have similar healthy and unhealthy features in their diets, even if the diets are not exactly similar.

One study investigated mother-child clustering of health behaviors in a broader sense [62]. In this Australian study, mothers who were identified as 'Fruit and vegetable eaters who don't sit down' had children more likely allocated to 'All-round healthy behaviors' and less likely to 'Screen-time focused' cluster. Mothers with 'Poor diet and little exercise' had children more likely allocated to 'Energy-dense eaters who watch' and less likely to 'All-round healthy behaviors' cluster. Thus, it seems that not only dietary behaviors, but also health behaviors in general, are probably at least somewhat similar between mothers and their children.

### 2.2.2 SUMMARY

Based on the 23 studies identified in this review of literature, parents and children seem to share at least somewhat similar dietary habits. Most of the studies examined similarities on a food group level, but also macro- and micronutrient intakes as well as dietary indices and clusters were investigated. Based on the studies reviewed here, it seems that parent-child dietary similarity is most consistent on a whole-diet level. Moderately convincing evidence for parent-child similarity in fruit and vegetable consumption was also found. Additionally, milk and/or dairy product consumption seems to correlate between parents and their children. On a macro- or micronutrient level, no consistent evidence on parent-child dietary resemblance was found. However, some evidence on parent-child dietary similarity in protein intake seemed to exist. Figure 3 shows the most convincing evidence on different levels of dietary behavior.


**Figure 3** Summary of the evidence regarding parent-child similarity in different levels of dietary behavior.

The findings of this literature review are not surprising: it is logical that parent-child dietary similarity is stronger on food consumption level than on nutrient intake level. Furthermore, similarities in nutrient intake are hard to interpret, since several nutrients can be obtained from different sources. For example, the observed similarity in protein intake might be explained by the relatively frequent consumption of milk in children and consumption of, for instance, meat in parents. Inconsistencies in results can also be explained by, for example, cultural factors.

Additionally, since the studies reviewed here used different dietary assessment methods and statistical methods (adjustments varied widely), the comparison of the studies is challenging. The most frequently used method both among the parents and the children was FFQ, followed by 24h recall and food records. The calculation of nutrient intakes from an FFQ is problematic – still, most of the studies reporting similarities in nutrient intakes used FFQs instead of 24h recalls or food records, which could have been more accurate. In 11 studies, the child's food consumption was reported by the mother or with assistance from the mother, whereas fathers acted as surrogate informants in one study. In 11 studies, either the children reported their own food consumption or the surrogate informant was not specified. Only a few studies presented results stratified by gender dyads (father-daughter, mother-son etc.) or other child or parental characteristics, such as race, BMI or household characteristics. Thus, these factors, which may be associated with parent-child dietary similarity, should be investigated in more detail in the future.

## 2.3 PHYSICAL HOME AND SCHOOL FOOD ENVIRONMENT AND DIET IN CHILDREN

In addition to social food environment, the physical food environment affects children's food behavior (Figure 1). Recently, the physical home environment as a determinant of food consumption among children has been widely studied. In review papers, the availability (whether certain foods are present in the home, for example in the refrigerator [63]) and accessibility (whether these foods are available in a form or location that facilitates their consumption, e.g., ready cut vegetable pieces on a table [63]) of fruit and vegetables in the home has been shown to be positively associated with the consumption of fruit and vegetables [29, 30, 64]. School food environments have also been investigated, but the results have been somewhat mixed: some studies have concluded that a healthy school food environment is essential in the prevention of obesity and unhealthy dietary behaviors [65], whereas other studies state that the current evidence of school food environment modification effectiveness is rather limited [66].

A systematic literature search in the PubMed database was performed on November 14th, 2017. The search command used was ("food availability" OR “food environment”) AND (child* OR famil*), and the search terms were restricted to title or abstract. The search was not restricted in terms of publication dates or article types. The search produced altogether 737 publications. Based on the titles and abstracts, 658 studies were excluded. The number of full text-articles assessed was 79, and of these, 39 were further excluded. The reasons for exclusion were missing food availability or food consumption measurement, availability measured in other contexts than home or school (for example neighborhood food availability), the age of the participating children (≤2 years or ≥15 years), not being observational or intervention study or the full text not being available in English. Additionally, sub-studies of this dissertation were excluded from the review. Altogether 40 studies were included in the literature review. Figure 4 describes the flow of papers.

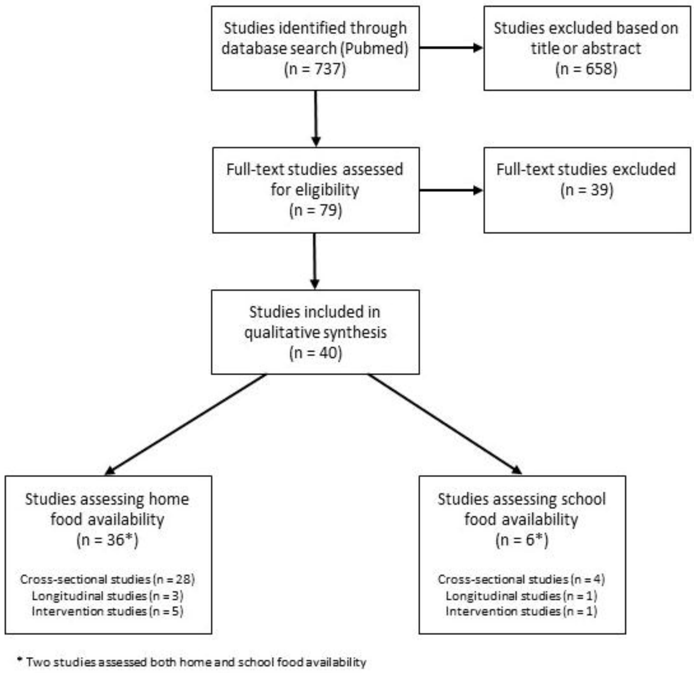


**Figure 4** The number of studies in each phase of the systematic literature search and the design of the studies included in the qualitative synthesis.

### 2.3.1 FOOD AVAILABILITY IN THE HOME

A total of 36 studies investigated the associations between home food availability and dietary behavior among children. The majority of the studies (28/36) were cross-sectional, but also interventions (n=5) and longitudinal studies (n=3) were identified. The following subsections review these studies.

### *2.3.1.1 Cross-sectional studies*

Altogether 28 cross-sectional studies were identified. A major part (13/28) of the studies were conducted in the USA and had elementary school-aged children as participants. Four studies were Australian, two were Belgian, and others were conducted in Canada, Denmark, Mexico, the Netherlands, the UK and Taiwan, one in each. One of the studies was a multi-national study with participants from eight European countries. Most of the studies used the availability of single food groups (mostly fruit and vegetable) as a measure of food availability and the most often used outcome was fruit and vegetable consumption. Details of the studies reviewed in this thesis are presented in Tables 4–6. Figure 5 describes the number of studies investigating the associations between food availability in the home and food behavior grouped by the level of both exposure and outcome.

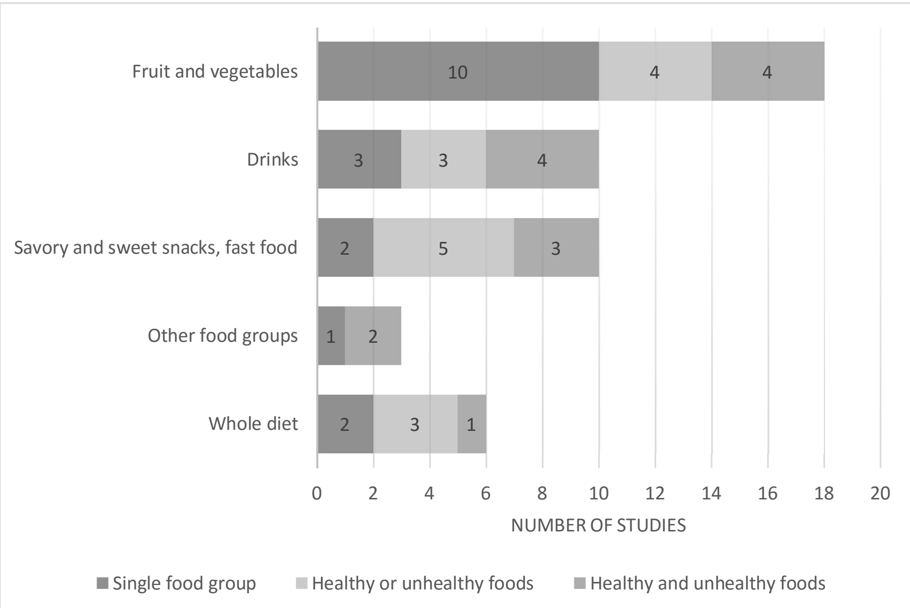


**Figure 5** The number of cross-sectional studies using the availability of single food group, healthy/unhealthy foods or healthy and unhealthy foods as the exposure grouped by different outcomes.

*Fruit and vegetable consumption*

Altogether 18 studies investigated the associations between food availability in the home and children's fruit and vegetable consumption, and the details of the studies are presented in Table 4. Two studies reported a positive association between fruit and vegetable availability in the home and fruit and vegetable consumption among preschool-aged children [67, 68]. Similar results were also reported in the studies with elementary school-aged children as participants [69-75]. Among a sample of US families participating in the Special Supplemental Nutrition Program for Women, Infants and Children (WIC), inverse associations between the availability of meat products and fruit consumption were found [76]. In addition, they reported negative associations between the availability of legumes and both fruit and vegetable consumption. However, the objective of the latter study was to investigate the role of food stamps (such as Supplemental Nutrition Assistance Program) in home food availability and dietary intake. Thus, the interpretation of the results may not be straightforward.

Three studies used composite scores to measure healthy or unhealthy home food availability [75, 77, 78]. Two studies used a composite score describing healthy home food environment or overall healthiness of the foods available in the home [77, 78]. In a US study, a positive association between food availability and vegetable intake was found among preschool-aged children, whereas food availability was not associated with fruit intake [77]. Similarly, a positive association between food availability and fruit and vegetable consumption was reported among US elementary school-aged children [78]. Ding et al. measured the availability of 16 foods available in the home and created three home food availability measures: more-healthful foods, less-healthful foods and more-healthful to less-healthful food ratio [75]. Neither the availability of more-healthful nor less-healthful foods were associated with fruit and vegetable consumption, whereas the more-healthful to less-healthful food ratio was positively associated with fruit and vegetable intake among US elementary school -aged children.

Four studies measured both healthy and unhealthy food availabilities and used them as exposure variables in multivariable models [79-82]. The availability of healthy foods in the home was positively associated with fruit and vegetable intake among US preschoolers, whereas availability of unhealthy foods was not [79]. Among elementary school-aged children, conflicting results were obtained: In a US study, an inverse association between unhealthy food availability and fruit and vegetable consumption was reported [80], whereas in a Belgian study, no such association was observed [82]. Instead, the Belgian study found a positive association between healthy food availability and fruit and vegetable consumption among girls, but not among boys. In a US study,

**Table 4.** *Details of the cross-sectional studies investigating the association between home food availability and fruit and/or vegetable consumption among children.*

| First author, publication year, country | Age of the children; ethnicity; number of participants in the analyses | Food availability measurement | Dietary assessment method | Results: fruit consumption | Results: vegetable consumption | Results: fruit & vegetable consumption |
|---|---|---|---|---|---|---|
| Amuta, 2015, USA [70] | School children; Hispanic or Latino, African American or Black; n=298 (47% girls) | The availability of a) fruit and b) vegetables on meals during the past seven days | FFQ, parent-reported | F: ↑ | V: ↑ | |
| Bruening, 2017, USA [76] | 2–5-year-olds; n=44 (64% girls) | Availability of 29 food items collapsed into 11 categories | 24h recall, mother-reported | P: ↓<br>S: ↑ | L: ↓ | |
| Campbell, 2013, Australia [74] | 5–12-year-olds; n=536 (53% girls) | Availability of a) fruit and b) vegetables in the home | FFQ, mother-reported | F: ↑ | V: ↑ | |
| Christian, 2013, the UK [71] | Mean age 8.3 years; White, mixed, Asian or British Asian, black or black British, Chinese or other ethnic group; n=1610 (47% girls) | The availability of fruit and vegetables in the home | FFQ, parent- or field-worker-reported (at school) | | | FV: ↑ |
| Couch, 2014, USA [80] | 6–11-year-olds; Hispanic, non-Hispanic or | Availability of a) high-calorie, nutrient-poor foods (chocolate candy, other | 2–3 x 24 h recall, with help from parents among 6–7-year-olds | | | U: ↓<br>H: 0 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | White, non-white; n=699 (50% girls) | candy, sweet pastries, chips or crackers, sweetened breakfast cereals, juice drinks, regular sodas, sport drinks) and b) low-calorie, nutrient-dense foods (raw fruits, baked chips, raw vegetables, unsweetened cereals) | | | | |
| Ding, 2012, USA [75] | 5–11-year-olds; non-Hispanic white, African American, Hispanic, other; n=116 (52% girls) | Availability of a) more-healthful foods (fruits, vegetables, 100% fruit juice, baked chips, sugar-free sodas, 1% fat or skim milk, unsweetened breakfast cereals), b) less-healthful foods (chocolates, candies, cakes, regular chips, juice drinks, sugared sodas, sports drinks, whole or 2% milk, sweetened breakfast cereals) and c) fruits and vegetables, a 'more-healthful to less-healthful food availability ratio' also calculated | FFQ | | | FV: ↑<br>U: 0<br>H: 0<br>H/U: ↑ |
| Downs, 2009, Canada [83] | $4^{th}$–$6^{th}$ graders; Cree; n=201 | Child-reported a) availability of fruits and vegetables and b) frequency of vegetables served at dinner | 3 x 24h recall, self-reported | FV: 0<br>VD: 0 | FV: 0<br>VD: 0 | |
| Goldman, 2012, USA [67] | 2–5-year-olds; Latino, African American, White, Asian, Interracial / other; n=229 (54% girls) | The availability of a) fruit and vegetables and b) fruit and vegetables that the child likes in the home | FFQ, parent-reported | | | FV: ↑ |

| | | | | | | |
|---|---|---|---|---|---|---|
| Haerens, 2008, Belgium [82] | 7th and 8th graders (mean age 12.7 years); n=534 (63% girls) | Child-reported availability of a) healthy products (water, fruit) and b) unhealthy products (soft drinks, candy, chips) | FFQ, self-reported | U: 0<br>H: ↑ ♀ | | |
| Krølner, 2009, Denmark [72] | 5th graders (mean age 11.4 years); Danish or not-Danish; n=1343 (51% girls) | The frequency of a) having fruit or vegetables available for the child to take, b) having fruit in bowl at home for the child to take and c) having different kinds of fruit or vegetables available at home | 24h recall and FFQ, self-reported | FV: ↑ | FV: ↑ | |
| López-Barrón, 2015, Mexico [73] | 5th graders (mean age 10.5 years); n=684 (55% girls) | Child-reported food inventory about foods purchased at home | FFQ | | | FV: ↑ |
| Ranjit, 2015, USA [84] | 8th graders (mean age 13.9 years); Black, Hispanic, White; n=2826 (52% girls) | Availability of healthy foods (vegetables, fruit, fruit juice) in the home during the past week | FFQ, self-reported | | | H: ↑ |
| Shier, 2016, USA [78] | Mean age 13.2 years; non-Hispanic white, non-Hispanic black, Hispanic or Latino, other; n=776–932 | Parent-reported healthiness of the food available in the home consisting of six statements: a) most of the food in the house is healthy; b) there are a lot of salty snacks in our house (a reverse coded item); c) there are a lot of sweets in our house (a reverse coded item); d) there are a lot of other high-fat foods in our house (a reverse coded item); e) there are a lot of | FFQ, self-reported | H: ↑ | H: ↑ | |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | sweetened beverages in our house (a reverse coded item); f) a variety of healthy foods is available to my child at each meal served at home | | | | |
| Shim, 2016, USA [77] | 2–5-year-olds; mostly White; n=316 (53% girls) | Healthy home food environment measure consisting of four statements: a) most of the food I keep in the house is healthy; b) I keep a lot of snack food (potato chips, Doritos, cheese puffs) in my house (a reverse coded item); c) a variety of healthy foods are available to my child at each meal served at home; d) I keep a lot of sweets (candy, ice cream, cakes, pies, pastries) in my home (a reverse coded item) | FFQ, mother-reported | H: 0 | H: ↑ | |
| Taylor, 2017, USA [79] | 2–7-year-olds; Caucasian, African American, Asian American, American Indian or Hawaiian Pacific, Multiracial, other; n=477 (46% girls) | Availability of a) unhealthy foods (seven items) and b) healthy foods (eight items) | FFQ, parent-reported | | | U: 0<br>H: ↑ |
| van Ansem, 2014, the Netherlands [69, 85] | 8–12-year-olds; native Dutch, immigrant background; n= 1269 (49% girls) | The availability of a) fruit and b) vegetables in the home | FFQ, parent-reported | F: ↑ | V: ↑ | |

| | | | | |
|---|---|---|---|---|
| Wang, 2013, USA [81] | 5–11-year-olds; mostly white; n=67 (58% girls) | Availability of a) chips and sweets (eight items) and b) fruits, vegetables and nuts (three items), | FFQ, parent-reported | U: 0<br>H: 0 |
| Wyse, 2011, Australia [68] | 3–5-year-olds; Aboriginal or Torres Strait Islander, other; n=396 (49% girls) | The number of varieties of fruit and vegetables currently in the home from a list of 19 fruits and 24 vegetables | FFQ, parent-reported | FV: ↑ |

F=Availability of fruit; V=Availability of vegetables, FV=Availability of fruits and vegetables, P=Availability of offal, processed meats or other proteins, S=Availability of sides or other foods, L=Availability of legumes, U=Availability of unhealthy foods, H=Availability of healthy foods, H/U=Ratio of healthy and unhealthy foods availabilities, VD=Availability of vegetables at dinner, ↑=positive association with fruit and/or vegetable consumption, ↓=inverse association with fruit and/or vegetable consumption, 0=no association with fruit and/or vegetable consumption home food availability was not associated with fruit and vegetable consumption [81].

Most of the studies reviewed here were conducted among elementary school-aged children. It is possible that the associations between home food availabilities and dietary behavior differ according to the age of the participants: for example, preschool-aged children are not able to report their diets themselves, but they may still eat foods that their parents do not know about (for instance, in preschool). Additionally, it is possible that the associations are different in different cultures, since majority of the studies referred to here have been conducted in the US.

*Consumption of drinks, snacks and fast food*

Altogether ten studies (for more detail, see Table 5) reported associations between home food availability and sugar-sweetened beverage intake among children [74, 76, 79, 80, 82-84, 86-88]. Home availability of sugar-sweetened beverages (SSBs) was positively associated with the consumption of SSBs among elementary school-aged children in three studies [74, 83, 87], whereas one study conducted among preschool children did not find such an association [76]. The availability of healthy foods in the home was, however, inversely associated with SSB consumption among US middle-schoolers in one study [84], whereas an Australian study reported a positive association between home availability of unhealthy foods and high-energy drink consumption among girls [86]. Additionally, milk consumption was associated with milk availability in one study [83] and healthy food availability in one study [84]. In a US study with families participating in WIC, inverse associations between the availabilities of several different food groups and the consumption of high-fat dairy among preschoolers were detected [76].

Conflicting results were obtained in four studies investigating healthy and unhealthy food availabilities in multivariable models [79, 80, 82, 88]. The availability of unhealthy foods was quite consistently positively associated with sugar-sweetened beverage consumption among elementary school -aged children [80, 82, 88]. However, an inverse association between healthy food availability and SSB consumption among girls was detected in an Australian study [88]. A positive association between unhealthy food availability and added sugar intake from SSBs was also detected among US preschoolers, whereas healthy food availability was not associated with the intake of added sugar from SSBs [79].

Of the identified cross-sectional studies, eight investigated the associations between food availability and snack consumption among school-aged children [74, 78, 80, 81, 84, 86, 88, 89] with somewhat similar results. The availability of snacks was positively associated with the consumption of snacks in two studies [74, 89]. Additionally, two studies reported an inverse association between healthy home food availability and snack intake [78, 84]. Furthermore, in an Australian study, unhealthy food availability in the home was positively associated with snack consumption [86]. Three studies incorporated healthy and unhealthy food availabilities in multivariable models. Chips and sweets availability was positively associated with fats and sweets consumption among overweight and obese US school children [81], whereas non-core food availability (foods not considered to be core components of a healthy diet, such as chips, chocolate, lollipops, biscuits, takeaway and fast foods) was positively associated with snack consumption among Australian school-aged girls [88]. However, one study did not find any associations between food availability and snack consumption [80].

Concerning food availability and consumption of other food groups among children, conflicting results were obtained. One study reported a positive association between the availability of energy-dense foods, such as soft drinks, juices, popcorn, cookies, chips and sweets, and their use [73]. Unhealthy food availability was not associated with fast food consumption in an Australian study [86], whereas in a Belgian sample, a positive association was detected [90]. Not surprisingly, a positive association between the availability of unhealthy foods and added sugar intake was found among US preschoolers [79]. However, since the calculation of added sugar intake is challenging, the results should be interpreted with caution.

*Whole diet*

Altogether six studies investigated the associations between home food availability and diet as a whole [60, 80, 84, 91-93]. The details of the studies are presented in Table 6. Studies used different measures of whole diet: three studies used non-established indices [84, 91, 92], that can be said to be based on general knowledge about healthy diet. One study used Healthy Eating Index (HEI) [93], which was originally designed in 1995 to describe overall diet quality in the US population [94], and has since been used extensively in population studies. In one study, Dietary Approaches to Stop Hypertension (DASH) score was used [80]. The DASH score measures adherence to a diet rich in foods that are associated with lower blood pressure, such as vegetables and fruits [95], and thus, also describes diet quality. Only one study used data-driven dietary patterns derived by cluster-analysis [60]. Unlike dietary indices, which are based on an interpretation of the previous findings concerning diet and health, data-driven dietary patterns describe the actual combinations of foods and drinks that are eaten together in a certain population.

In a sample of 187 Hispanic school-aged children, the availabilities of fruits, vegetables, 100% fruit juice, milk or snacks were not associated with HEI scores, whereas having soda and fruit drinks in the home were associated with

**Table 5.** *Details of the cross-sectional studies investigating the association between home food availability and drinks, snacks and/or fast food consumption among children.*

| First author, publication year, country | Age of the children; ethnicity; number of participants in the analyses | Food availability measurement | Dietary assessment method | Results: SSB consumption | Results: milk or dairy consumption | Results: salty/sweet snack or fast food consumption |
|---|---|---|---|---|---|---|
| Bruening, 2017, USA [76] | 2–5-year-olds; n=44 (64% girls) | Availability of 29 food items collapsed into 11 categories | 24h recall, mother-reported | S: 0 | D: ↓ | SA: 0<br>SW: 0 |
| Campbell, 2007, Australia [86] | 12–13-year-olds; born in Australia, UK or Ireland; n=347 (50% girls) | Child-reported availability of ten food items, which were entered in PCA, unhealthy food availability factor extracted | FFQ, self-reported | U: ↑ ♀ | | U: ↑ |
| Campbell, 2013, Australia [74] | 5–12-year-olds; n=536 (53% girls) | Availability of a) fruit and b) vegetables in the home | FFQ, mother-reported | S: ↑ | | SA: ↑<br>SW: ↑ |
| Couch, 2014, USA [80] | 6–11-year-olds; Hispanic, non-Hispanic or White, non-white; n=699 (50% girls) | Availability of a) high-calorie, nutrient-poor foods (chocolate candy, other candy, sweet pastries, chips or crackers, sweetened breakfast cereals, juice drinks, regular sodas, sport drinks) and b) low-calorie, nutrient-dense foods (raw fruits, baked chips, raw vegetables, unsweetened cereals) | 2–3 x 24 h recall, with help from parents among 6–7-year-olds | U: ↑<br>H: 0 | | U: 0<br>H: ↑ |

| | | | | | | |
|---|---|---|---|---|---|---|
| De Decker, 2017, Belgium [90] | 7–14-year-olds; Dutch speaking; n=174 (49% girls) | Availability of unhealthy foods based on two statements | FFQ, parent-reported | | | U: ↑ |
| Downs, 2009, Canada [83] | 4th–6th graders; Cree; n=201 | Child-reported a) availability of fruits and vegetables and b) frequency of vegetables served at dinner | 3 x 24h recall, self-reported | S: ↑ | D: ↑ | |
| Haerens, 2008, Belgium [82] | 7th and 8th graders (mean age 12.7 years); n=534 (63% girls) | Child-reported availability of a) healthy products (water, fruit) and b) unhealthy products (soft drinks, candy, chips) | FFQ, self-reported | U: ↑ ♂<br>H: 0 ♀ | | |
| Hang, 2007, Taiwan [89] | 4th–6th graders; n=772 (47% girls) | Child-reported availability of healthy (100% milk products, 100% fruit juices and fresh fruit) and unhealthy snacks (salty and sweet high-fat snacks, candies, SSBs, high-fat fast foods) | FFQ, self-reported | | | SA, SW: ↑ |
| López-Barrón, 2015, Mexico [73] | 5th graders (mean age 10.5 years); n=684 (55% girls) | Child-reported food inventory about foods purchased at home | FFQ | | | U: ↑ |
| Ranjit, 2015, USA [84] | 8th graders (mean age 13.9 years); Black, Hispanic, White; n=2826 (52% girls) | Availability of healthy foods (vegetables, fruit, fruit juice) in the home during the past week | FFQ, self-reported | H: ↓ | H: ↑ | H: ↓ |
| Santiago-Torres, 2016, USA [87] | 5th–8th graders (mean age 11.9 years); Hispanic; n=173 (53% girls) | Availability of soda, fruit drinks and milk | FFQ, self-reported | S: ↑ | | |

| | | | | | |
|---|---|---|---|---|---|
| Shier, 2016, USA [78] | Mean age 13.2 years; non-Hispanic white, non-Hispanic black, Hispanic or Latino, other; n=776–932 | Parent-reported healthiness of the food available in the home consisting of six statements: a) most of the food in the house is healthy; b) there are a lot of salty snacks in our house (a reverse coded item); c) there are a lot of sweets in our house (a reverse coded item); d) there are a lot of other high-fat foods in our house (a reverse coded item); e) there are a lot of sweetened beverages in our house (a reverse coded item); f) a variety of healthy foods is available to my child at each meal served at home | FFQ, self-reported | H: ↓ | H: ↓ |
| Taylor, 2017, USA [79] | 2–7-year-olds; Caucasian, African American, Asian American, American Indian or Hawaiian Pacific, Multiracial, other; n=477 (46% girls) | Availability of a) unhealthy foods (seven items) and b) healthy foods (eight items) | FFQ, parent-reported | U: ↑<br>H: 0 | U: ↑<br>H: 0 |
| Wang, 2013, USA [81] | 5–11-year-olds; mostly white; n=67 (58% girls) | Availability of a) chips and sweets (eight items) and b) fruits, vegetables and nuts (three items), | FFQ, parent-reported | | SA + SW: ↑<br>FV: 0 |
| Zarnowiecki, 2015, Australia [88] | 9–13-year-olds; born in Australia, UK/Ireland, Other, Aboriginal | Home availability of a) fruit and vegetables (five items) and b) non-core foods and drinks (four items) | FFQ, self-reported | FV: 0 ♂<br>SA+SW: 0 ♂<br>FV: ↓ ♀ | FV: 0 ♀<br>SA+SW: 0 ♀<br>SA+SW: ↑ ♂ |

| | | |
|---|---|---|
| | or Torres Strait Islander; n=395 | SA+SW: ↑ ♀ |

SSB=Sugar-sweetened beverages, S=Availability of SSBs, D=Availability of dairy, SA=Availability of salty snacks, SW=Availability of sweet snacks or desserts, U=Availability of unhealthy foods, H=Availability of healthy foods, FV=Availability of fruit, vegetables and nuts, ↑=positive association with SSB, milk/dairy or salty/sweet snack consumption, ↓=inverse association with SSB, milk/dairy or salty/sweet snack consumption, 0=no association with SSB, milk/dairy or salty/sweet snack consumption lower HEI scores [93]. This is an interesting finding, since the study linked the availability of sugar-enriched drinks, but not that of any foods, with dietary quality. However, the finding might be culture-specific, since the study was conducted among Hispanic children in the US. However, a large European study also connected soft drink availability with a 'sweet and fat' dietary pattern, which was extracted using cluster analysis [60]. Soft drink availability was not associated with the other two dietary clusters, 'refined cereals' or 'animal products'.

Three studies investigated the associations between healthy or unhealthy food availabilities and whole-diet. Among US school-children, a positive association between the availability of healthy foods in the home and healthy diet score was found [84]. In the same study, an inverse association between the availability of healthy foods in the home and unhealthy diet score was observed. In a different sample, the availability of healthy foods was positively associated with SPAN Healthy Eating Index (SHEI) and healthy food intake and inversely associated with unhealthy food intake [92]. Restriction of unhealthy foods was positively associated with SHEI and inversely associated with unhealthy food intake. One of the few studies investigating these associations among preschoolers found that limited access to unhealthy foods was positively associated with healthy food intake score and inversely associated with 'junk' food intake score [91].

In one study, the associations between food availability and whole diet among 6–11-year-olds were investigated in a multivariable model with healthy and unhealthy food availabilities as exposures. In this US sample, the availability of healthy foods was positively and the availability of unhealthy foods inversely associated with the DASH score [80]. However, as other home environmental and individual factors, such as parenting styles or parental BMI were also entered simultaneously in the model, the interpretation is not straightforward.

*Summary of the cross-sectional studies*

In summary, consistent evidence from cross-sectional studies shows that the availability of fruit and vegetables in the home is associated with fruit and vegetable consumption among children. Additionally, some studies suggest that the availability of SSBs and unhealthy foods (e.g., sweet and savory snacks, SSBs and take-out food) are associated with SSB consumption, at least among school-aged children. Studies investigating home food availability and snack consumption have yielded inconsistent results. One reason for this might be the different definitions of 'snacks': whereas in other studies, snacks have been defined as mostly unhealthy foods, other studies might have included also snacks that are not purely healthy nor unhealthy. On a whole-diet level, studies show that the availability of healthy foods is associated with overall healthy

**Table 6.** *Details of the cross-sectional studies investigating the association between home food availability and whole diet among children.*

| First author, publication year, country | Age of the children; ethnicity; number of participants in the analyses | Food availability measurement | Dietary assessment method | Whole diet measurement | Results: healthy diet | Results: unhealthy diet |
|---|---|---|---|---|---|---|
| Couch, 2014, USA [80] | 6–11-year-olds; Hispanic, non-Hispanic or White, non-white; n=699 (50% girls) | Availability of a) high-calorie, nutrient-poor foods (chocolate candy, other candy, sweet pastries, chips or crackers, sweetened breakfast cereals, juice drinks, regular sodas, sport drinks) and b) low-calorie, nutrient-dense foods (raw fruits, baked chips, raw vegetables, unsweetened cereals) | 2–3 x 24 h recall, with help from parents among 6–7-year-olds | DASH score | U: ↓<br>H: ↑ | |
| Hebestreit, 2017, Belgium, Estonia, Cyprus, Germany, Hungary, Italy, Spain & Sweden [60] | 6–16-year-olds; n=1976 (51% girls) | Availability of soft drinks during meals | 24h recall, children under 11 years were advised to ask their parents for help | Cluster analysis: ‘sweet and fat’ pattern | | S: ↑ |
| Ranjit, 2015, USA [92] | 4th graders (mean age 9.6 years); Black, Hispanic, | Parent-reported availability of a) healthy foods (fruits, vegetables, milk and whole grain products) | FFQ, self-reported | SHEI | U: ↓<br>H: ↑ | |

| | | | | | | |
|---|---|---|---|---|---|---|
| | White, other; n=3001 (53% girls) | and b) unhealthy foods in the home | | | | |
| Ranjit, 2015, USA [84] | 8th graders (mean age 13.9 years); Black, Hispanic, White; n=2826 (52% girls) | Availability of healthy foods (vegetables, fruit, fruit juice) in the home during the past week | FFQ, self-reported | Healthy diet index; Unhealthy diet index | H: ↑ | H: ↓ |
| Santiago-Torres, 2014, USA [93] | 5th–8th graders (mean age 11.9 years); Hispanic; n=187 (53% girls) | Parent-reported availability of a) fruits, b) vegetables, c) 100% fruit juice, d) milk, e) soda, f) fruit drinks, and g) snacks | FFQ, self-reported | HEI | F: 0<br>V: 0<br>FJ: 0<br>D: 0<br>S: ↓<br>FD: ↓<br>SA: 0 | |
| Østbye, 2013, USA [91] | 2–7-year-olds; Black, White, other; n=190 (44% girls) | Parent reported access to unhealthy foods (four items, such as soda and unhealthy snacks) | FFQ, mother-reported | 'Junk' food score; Healthy food score | U: ↓ | U: ↑ |

DASH=Dietary Approaches to Stop Hypertension, U=Availability of unhealthy foods, H=Availability of healthy foods, S=Availability of soft drinks, SHEI=SPAN Healthy Eating Index, HEI=Healthy Eating Index, FD=Availability of fruit drinks, F=Availability of fruits, V=Availability of vegetables, FJ=Availability of 100% fruit juice, D=Availability of milk, SA=Availability of snacks, ↑=Positive association between food availability and diet, ↓=Inverse association between food availability and diet, 0=No association between food availability and diet

diet among children, whereas unhealthy food availability is inversely associated with healthy diets.

The studies reviewed here have used different food availability measures as well as dietary assessment methods. Some of the conflicting or inconsistent findings may rise from the different use of methods and definitions, as well as from the different age groups studied: older children can take foods themselves, whereas younger children need their parents to give them food. In addition, only a handful of studies have examined the association between home food availability and food consumption with multivariable models allowing the comparison of healthy and unhealthy food availabilities. It is possible that by measuring home food availability as availability of a single food or as availability of healthy foods, the researchers have failed to detect some of the possible associations, since there usually are both healthy and unhealthy food items available in one's home at the same time. Furthermore, studies reviewed here were mostly conducted among US populations. Additionally, only a few studies have looked at preschoolers, who are more dependent on their parents or caretakers and can thus show different patterns when it comes to food availability.

#### *2.3.1.2 Longitudinal studies*

The literature search identified three longitudinal studies (for more detail, see Table 7) investigating home food availability and dietary behaviors among children [52, 96, 97]. Among 609 Belgian school-aged children, baseline availability of unhealthy foods in the home was inversely associated with fruit and vegetable consumption at 3-year follow-up and positively associated with sugar-sweetened soft drink, sweet and crisp consumption [52]. A somewhat similar effect was observed among US middle-schoolers during a 5-year follow-up: baseline availability of unhealthy foods in the home was positively associated with the consumption of fast-food among girls, but not among boys [96]. However, in this US study, no associations were found between baseline availability of healthy foods and fast-food consumption at follow-up. Only one longitudinal study investigated younger children: no association between baseline home food availability at the age of 18 months and dietary quality at age 3.5 years was observed [97].

Since only three longitudinal studies were available for narrative synthesis, no firm conclusions can be drawn. However, the two studies conducted among school-aged children [52, 96] suggest that availability of unhealthy foods in the home may lead to unhealthy dietary habits later on and should be of special interest when aiming at improving dietary habits among children. However, based on the US study [96], the associations might differ between genders, and more research is needed to confirm these results.

**Table 7.** *Details of the longitudinal studies investigating the association between home food availability and diet among children.*

| First author, publication year, country | Age of the children; ethnicity; number of participants in the analyses | Food availability measurement | Dietary assessment method | Dietary outcomes | Results |
|---|---|---|---|---|---|
| Bauer, 2008, USA [96] | Middle-schoolers (mean age 12.8 years); White, African American, Asian, Hispanic, other; n=744 (55% girls) | Availability of a) healthy foods (fruits and vegetables, milk, fruit juice, vegetables at dinner) and b) unhealthy foods (junk food, salty snacks, chocolate and candy, soda) | FFQ, self-reported 5 years after the baseline | Fast-food consumption | H: 0<br>U: O ♂<br>U: ↑ ♀ |
| Collins, 2016, Australia [97] | Toddlers (18 months); n=229 (50% girls) | Availability of a) fruits, b) vegetables, c) fruit juice and soft drinks, d) energy-dense foods (three items) | 3 x 24h recall (telephone-based), parent-reported 2 years after the baseline | RC-DQI | F: 0<br>V: 0<br>FJ: 0<br>ED: 0 |
| Vereecken, 2010, Belgium [52] | 9–11-year-olds; n=600 (49% girls) | Availability of unhealthy foods (soft drinks, biscuits, sweets, crisps) | FFQ, self-reported 3 years after the baseline | F&V<br>SSC | U: ↓<br>U: ↑ |

RC-DQI=Revised Children's Diet Quality Index, F&V=Consumption of fruits and vegetables, SSC=Consumption of soft drinks, sweets and crisps, H=Availability of healthy foods at baseline, U=Availability of unhealthy foods at baseline, F=Availability of fruits at baseline, V=Availability of vegetables at baseline, FJ=Availability of fruit juices and soft drinks at baseline, ED=Availability of energy-dense foods at baseline, 0=No association between food availability at baseline and diet at follow-up, ↑=Positive association between food availability at baseline and diet at follow-up, ↓=Inverse association between food availability at baseline and diet at follow-up

#### 2.3.1.3 Interventions

The literature search identified five papers describing four intervention studies that investigated the associations between food availability and food consumption among children [98-102]. The details of the identified studies are presented in more detail in Table 8. All the studies were conducted in USA or Australia, and the outcomes measured varied with fruit and vegetable consumption being measured in three papers [99, 101, 102]. Of the four intervention studies, two were randomized controlled trials (RCT) [98, 99, 101], whereas the other two had no control group [100, 102].

The Healthy Habits intervention aimed at improving the diet of preschool-aged children by targeting parental and home food environmental factors [103]. The intervention was telephone-based and lasted for one month. Follow-up data was measured at 2, 6 and 12 months. Compared to the control group children, the children in the intervention group consumed significantly more fruit and vegetables at the 12-month follow-up [104]. Nevertheless, the availability of vegetables and fruits in the home did not differ between the intervention and control groups and thus, the effect of the intervention could not have been mediated by home food availability [99]. However, in the same intervention, change in the home food availability of non-core foods (for example, sugar-enriched cereals, biscuits, crisps, confectionary, sweets, take-away foods etc.) was associated with a reduction in non-core food consumption among the intervention group [98]. Thus, based on the Healthy Habits intervention, it seems that it is possible to influence both home food availability and dietary habits among families, but the intervention effects may differ between healthy and unhealthy foods.

A US paper described a 12-month family-based intervention, in which the participants were invited into 10 monthly group sessions and received bimonthly phone calls with trained staff [101]. The objective of the intervention was to prevent excess weight gain. Compared to the children in the control group, the children in the intervention group were less likely to consume sugar-sweetened beverages at the end of the intervention. However, no statistically significant differences between the intervention and control group participants were detected in the availability of fruit and vegetables in the home, fruit and vegetables consumption or HEI scores.

In an Australian intervention the parents received advice regarding a switch from regular-fat foods to reduced-fat foods [100]. The nutrition information was delivered with face-to-face sessions held one month apart over 12 weeks. In this intervention, the change in perceived fresh food availability was not associated with change in percentage of energy from saturated fat, which was the primary goal of the intervention. This is not surprising, since the parents were not encouraged to increase the availability of fresh foods in the home during the intervention.

Odoms-Young et al. investigated the possible effects of changes in program regulations governing the WIC (the Special Supplemental Nutrition Program for Women, Infants, and Children) food packages in home food availability and children's dietary intakes [102]. Six months after the change in the food package policy, the availability of wholegrain items, low-fat milk, fruit juices and vegetables in the home increased and that of whole milk decreased among Hispanic and African American participants. Additionally, the intake of saturated fat and whole milk decreased among the Hispanic participants, whereas the intake of fiber, low-fat milk and whole grains increased. Among the African American participants, the intake of whole milk decreased, whereas an increase in the intake of energy, low-fat milk and sugar-sweetened beverages increased. The analyses did not, however, investigate the associations between the changes in food availability and changes in food intake.

Based on the identified intervention studies, no convincing evidence of the effect of home food availability on children's diet exists. Furthermore, based on the three papers reporting results from two RCTs [98, 99, 101], it seems that changing the home food availability, especially in regard to fruit and vegetables, is challenging. However, the RCTs were still able to increase the consumption of fruits and vegetables among children. It is possible that this change was due to intervention components other than home food availability, but one can also hypothesize that the change in the availability of unhealthy foods in the home could have led to increased fruit and vegetables consumption.

#### *2.3.1.4 Summary*

The associations between food availability in the home and diet in children has been mostly studied in cross-sectional, observational settings. Moderately convincing evidence links higher availability of fruits and vegetables to higher consumption of fruits and vegetables among children. In addition, there is some evidence linking unhealthy home food availability, such as the availability of SSBs and salty or sweet snacks to unhealthy dietary behaviors. Though only a handful of studies have examined the associations between home food availability and whole diet, parallel findings seem to arise. Considering also the evidence from longitudinal and intervention studies, it seems that the role of unhealthy home food availability needs special attention. Thus, food availability should be measured more comprehensively using both dimensions: healthy and unhealthy. In addition, since most of the studies have been conducted in a cross-sectional design, the direction of the possible association is debatable, and more longitudinal and intervention studies are needed to con

**Table 8.** *Details of the intervention studies investigating the associations between home food availability and diet among children.*

| First author, publication year, country | Age of the children; ethnicity; number of participants in the analyses | Food availability measurement | Dietary assessment method | Dietary outcomes | Brief description of the intervention | Results |
|---|---|---|---|---|---|---|
| Fletcher, 2013, Australia [98] | 3–5-year-olds; n=356 (49% girls) | Availability and accessibility of a) salty snacks, b) sweet snacks, c) confectionary, d) drinks in the home | FFQ, parent-reported | Non-core food[a] consumption | 1-m telephone-delivered RCT, additional written advice | Access to non-core foods[a] in the home mediated the intervention effect on non-core food consumption |
| Fulkerson, 2017, USA [101] | 8–12-year-olds; White, Black, American Indian / Asian / multiracial; n=160 (47% girls) | Availability of a) fruits (26 items) and b) vegetables (21 items) | 3 x 24h recall, parents were allowed to assist when needed | F&V intake, SSB intake, HEI2010 | 12-m RCT with group sessions and goal-setting calls | Availability of F&V did not change during the intervention; no difference in F&V intake or HEI2010 after the intervention; intervention group consumed less SSBs after the intervention |
| Hendrie, 2013, Australia [100] | 4–13-year-olds;n=133 (40% girls) | Perceived fresh food availability (four items) | 3 x 24h recall, parent-assisted among 11–13-year-olds | Change in saturated fat E% | 12-w intervention with face-to-face meetings with a dietitian | Change in perceived fresh food availability was not associated with change in saturated fat E% |

| | | | | | | |
|---|---|---|---|---|---|---|
| Odoms-Young, 2014, USA [102] | 2–3-year-olds; Hispanic, African American; n=121 (49% girls) | Availability of a) fruits (25 items), b) fruit juices (4 items), c) vegetables (25 items) and d) whole-grain products (3 items) | 24h recall, mother-reported | Energy, fat E%, saturated fat E%, fiber, fruits, 100% fruit juice, vegetables, low-fat or skim milk, whole milk, SSBs, whole grains | 6-m intervention with changes in WIC food packages, wider variety of foods offered | Availability of wholegrain items, 100% fruit juice, vegetables and wholegrain products increased; changes in the intake of energy, fat, milk, fiber, whole-grains and SSBs |
| Wyse, 2015, Australia [99] | 3–5-year-olds; n=329 (49% girls) | Availability of a) fruits (19 items) and b) vegetables (24 items) | FFQ, parent-reported | F&V consumption | 1-m telephone-delivered RCT, additional written advice | Availability of F&V in the home did not mediate the intervention effect on F&V consumption |

[a]For example sugar-enriched cereals, biscuits, crisps, confectionary, sweets, take-away foods etc., F&V=Fruits and vegetables, SSB=Sugar-sweetened beverages, HEI=The Healthy Eating Index, WIC= The Special Supplemental Nutrition Program for Women, Infants, and Children

firm this. Furthermore, more studies among preschoolers and in different cultural settings should be conducted, since the associations may vary in different settings.

### 2.3.2 FOOD AVAILABILITY IN SCHOOL

Compared to home food availability, the concept of school food availability is possibly more complex. Food availability in school may include, for instance, school lunch, foods sold to pupils in the canteen or in vending machines, and, in addition, shops and restaurants in the vicinity of the school may have an influence on the diet of the children. Furthermore, schools may have policies that restrict or promote the sell of certain foods in the school, which makes it hard to distinguish the effects of social, cultural or political food environments from the physical aspect of the food environment. However, the literature search identified six studies investigating the associations between food availability in school and food consumption among children [72, 73, 105-108]. Half of the studies were conducted in cross-sectional settings, whereas two studies were longitudinal and one was an intervention study. More details about the studies can be found in Tables 9 and 10.

#### *2.3.2.1 Cross-sectional studies*

The definition of the school food availability varied between studies. School food availability was measured as the existence of a school fruit subscription program and the presence of a canteen or food booth in the school [105], the availability of fruit and vegetables as well as unhealthy foods in the school [72, 108] or with an inventory list [73]. In addition, different informants were used (headmasters or other school administrators, canteen staff). All four cross-sectional studies identified used fruit and vegetable consumption as one of the outcomes. Other outcomes used were snack and beverage consumption and the consumption of energy-dense foods (soft drinks, juice, popcorn, cookies, chips and peanuts, sweets and candies).

In a Danish study, having fruit and vegetables and unhealthy foods available (on sale) in the school was associated with higher fruit and vegetable intake among boys as compared to having only fruit and vegetables available [72]. One possible explanation for this rather counterintuitive result may be that these schools had overall a wider variety of foods available and thus, the pupils were able to buy their preferred fruits or vegetables, as the authors discussed. Challenges in measuring food availability might also explain the mixed findings. In a Norwegian sample, no statistically significant associations between school food availability and snack, sugar-sweetened beverage, fruit or vegetable consumption were detected [105]. Similar results were obtained in a US

**Table 9.** *Details of the cross-sectional studies investigating the associations between school food availability and diet among children.*

| First author, publication year, country | Age of the children; ethnicity; number of participants in the analyses | Food availability measurement | Dietary assessment method | Main results |
|---|---|---|---|---|
| Gebremariam, 2012, Norway [105] | 6th graders (mean age 11.2 years); n=1425 (48% girls) | a) Existence of a school fruit subscription program (with or without payment) and b) presence of a canteen or food booth | FFQ | School food availability not associated with fruit, vegetable, snack or beverage consumption |
| Krølner, 2009, Denmark [72] | 5th graders (mean age 11.4 years); Danish or not Danish; n=1343 (51% girls) | Headmaster-reported availability of a) fruits and/or vegetables and b) unhealthy food choices (e.g., cakes, biscuits, soft drinks etc.) on sale | 24h recall, FFQ | Having both fruits and vegetables and unhealthy foods available in school was positively associated with fruit and vegetable intakes among boys, but not among girls |
| López-Barrón, 2015, Mexico [73] | 5th graders (mean age 10.5 years); n=684 (55% girls) | Staff-reported school food inventory list (13 items) in the school canteens | FFQ | Availability of energy-dense foods within school positively correlated with the consumption of energy-dense foods |
| Vericker, 2012, USA [108] | 5th and 8th graders; n=5530 | School administrator-reported availability of a) healthy and b) unhealthy competitive foods and beverages[a] | FFQ | School food availability not associated with fruit and vegetable nor SSB consumption |

[a]Any foods and beverages sold to students in school that are not part of the National School Lunch Program

study, which also suggested that the associations may vary according to gender, ethnicity or socioeconomic status [108]. A Mexican study reported a positive correlation between weekly consumption of energy-dense foods and their availability within school [73]. However, the latter study did not report the methods used in detail making it hard to compare the results with the other studies. In addition, also for example school lunch policies may vary between countries, which may have affected the results.

#### *2.3.2.2 Longitudinal studies*

One longitudinal study investigated the associations between school food availability and 11–13-year-olds' consumption of fruit, vegetables, sugar-sweetened beverages and non-core foods, such as potato chips or chocolate [106]. In this Australian study, the school food availability as measured with rating of canteen choices from unhealthy to healthy did not change over a one-year period, whereas the consumption of non-core foods and sugar-sweetened beverages among students decreased [106]. Thus, based on longitudinal studies identified in the literature review, there is no clear association between school food availability and diet among children, but more studies with more rigorous methods are needed to confirm this finding.

#### *2.3.2.3 Intervention studies*

One intervention study reported the effects of a policy change in two middle schools, where the school food environment was modified by removing juice drinks and allowing only non-flavored bottled water in vending machines and making seasonal fruit and vegetable bar available to all students [107]. Compared to the control school students, the students in the intervention schools were more likely to consume fewer amounts of juice and pastries in school, whereas no differences between the intervention and control school students were detected in fruit or vegetable consumption during school hours. Furthermore, the intervention school students were more likely to consume higher amounts of milk outside school.

#### *2.3.2.4 Summary*

Based on cross-sectional and longitudinal studies, it seems that no clear association between school food availability and children's food consumption has been established. Since school food policies can affect school food availability, researchers may have used different wording in their papers resulting in only six studies to be identified in this literature review. Thus, drawing any firm conclusions is challenging. One intervention study showed that modification of the school food environment can affect food consumption among children, and the intervention effect can even outreach school borders. The comparison of studies is challenging, since the policies in different countries and schools may affect school food availability and food consumption differently. Furthermore, the school food availability as well as food consumption has been measured variously in the studies. More studies in varied settings and with rigorous measurements are needed.

# 3 AIMS OF THE THESIS

Social and physical environments have been linked to dietary behavior among children. Based on earlier studies, parental food consumption and home food availability – which can be used as measures of social and physical home food environments – seem to be associated with children's food consumption. However, to this day, the majority of the studies have measured consumption of certain food groups, such as fruit and vegetables, although in real life, people eat a number of different foods in different combinations. Thus, the overall aim of this thesis was to investigate the associations between home and school food environments and food behavior in children using a whole-diet approach. Both social home food environment (parent-child dietary resemblance as a proxy for role modelling) and physical home and school food environments (food availability) were examined.

Specific aims were as follows:

I To evaluate dietary resemblance between Finnish parents and preschoolers and determine whether sociodemographic factors are associated with parent-child dietary resemblance.

II To determine whether food availability in the home is associated with dietary patterns among Finnish preschoolers.

III To determine whether food availability in the home and in school is associated with dietary patterns among 9–11-year-old children from 12 countries.

# 4 PARTICIPANTS AND METHODS

## 4.1 STUDY DESIGNS AND PARTICIPANTS

This study used data from two research projects: the DAGIS study, which aimed at investigating energy balance-related behaviors and stress regulation among Finnish preschoolers, and the ISCOLE study, which was an international study aiming at investigating the associations between lifestyle behaviors, environmental factors and obesity. The studies are presented in more detail in the subsequent chapters.

### 4.1.1 THE DAGIS STUDY

In papers I and II, data from the cross-sectional phase of the DAGIS study (Increased Health and Wellbeing in Preschools) [109] has been used. The study obtained a favorable ethical statement from the University of Helsinki Review Board in the Humanities and Social and Behavioral Sciences in February 2015. Based on socioeconomic status indicators (larger variation of educational level, income level and higher Gini coefficient) [110], eight Finnish municipalities, all of which agreed, were asked to participate in the study in 2015. From the participating municipalities, all municipal preschools and private preschools from whom the municipalities purchased education services were included in random selection of preschools, and we randomly selected 169 preschools to be invited to take part in the study. The number of selected preschools was based on power and sample size calculations [109], and the random selection of preschools was conducted separately for each of the participating municipalities. Of the invited 169 preschools, 67 (40%) did not wish to participate. In addition, we excluded 16 preschools (9%) due to being a 24-hour preschool, operating in a language other than Finnish or Swedish (the official languages of Finland), or not having reduced fees for low-income families. A written informed consent was received from 86 preschools (51% of those invited).

From the consenting preschools, we invited all the children from groups with 3–6-year-olds (N=3592) and their families to participate in the study. Children in preschools with a low participation rate (≤30% in each of the preschool groups for 3–6-year-olds; 91 children in 20 preschools) were excluded. Altogether 892 children from 66 preschools consented (25% of those invited), and data was received from 864 (24% of those invited in total; 29% of those invited from the participating 66 preschools). The data were collected between September 2015 and April 2016. Figure 6 presents the flow of preschools and participants.

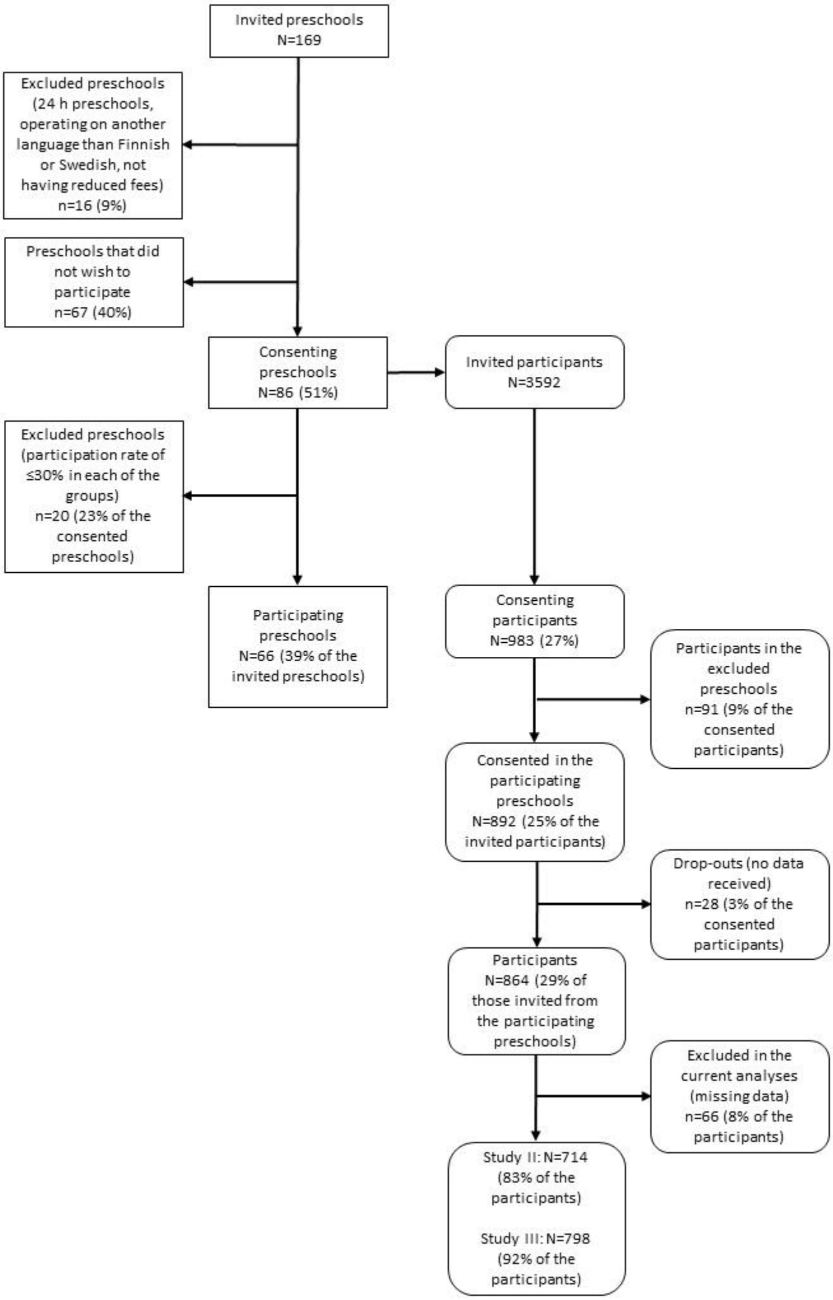


**Figure 6** The number of participating preschools and children in the DAGIS study.

### 4.1.2 THE ISCOLE STUDY

In paper III, data from the International Study of Childhood Obesity, Lifestyle and the Environment (ISCOLE) was used. The participants were 9–11-year-olds from 12 study sites from Australia, Brazil, Canada, China, Colombia, Finland, India, Kenya, Portugal, South Africa, the United Kingdom, and the United States. The study sites are shown in Figure 7. The Institutional Review Board at the Pennington Biomedical Research Center (coordinating center) and the Institutional/Ethical Review Boards at each participating institution approved the study protocol. To provide a sufficient sample of 500 students per site, the 12 study sites identified one or more school districts from urban and suburban areas within reasonably close proximity to the local study center [111]. The primary sampling unit was the school, and, in order to maximize variability within sites, the sampling was typically stratified by indicators of socio-economic status. From the participating schools, classes best corresponding to 10-year-old students were subject to sampling. The sampling strategies employed varied within these general parameters between the study sites [111]. A total of 7806 children assented and received parental legal guardian consent to participate in the ISCOLE study. An informed consent was received from 7372 children (94%), of which a total of 6685 (91% of the overall study sample, 54% girls) had sufficient data available and were included in paper III. The data were collected between September 2011 and December 2013.

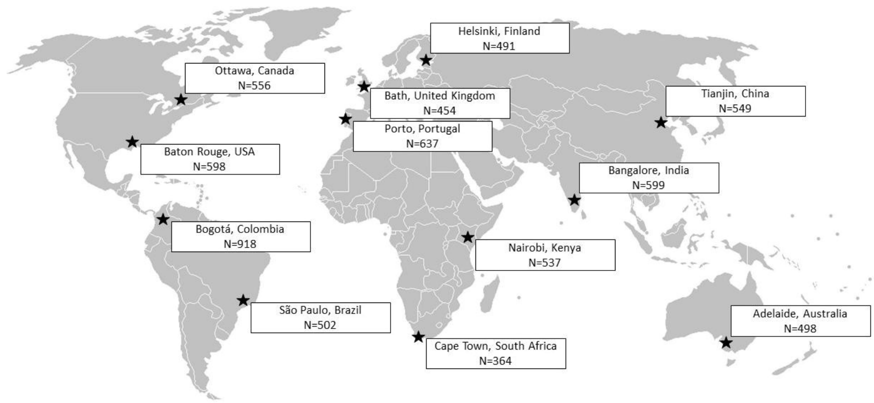


**Figure 7** The study sites in the ISCOLE study (Figure adapted from [111]).

## 4.2 DIETARY ASSESSMENT

### 4.2.1 FOOD CONSUMPTION

In papers I and II, a parent or legal guardian filled in a 47-item FFQ on behalf of the participating child by indicating how many times during the past week the child had consumed each of the foods included in the FFQ. Since preschools in Finland provide the children with three free meals during the day [112], most of the differences in the diets of Finnish preschoolers are probably due to foods eaten outside preschool hours. Additionally, the parents would not have been able to assess the foods the children had eaten during the day. Thus, the FFQ was intentionally restricted to not cover municipality-provided foods and drinks consumed during preschool hours. The FFQ included three answer columns: ‘not at all’, ‘times per week’ and ‘times per day’. The instruction was to either tick the ‘not at all’ -box or to write a number in one of the other columns. The FFQ was designed to measure especially the consumption of vegetables, fruits, and berries as well as sugar-enriched foods among preschool children. Altogether seven food groups (vegetables, fruits and berries; dairy products; fish; meat and eggs; cereal products; drinks; and others, i.e. sweets and snacks) were included in the FFQ. In paper I, the parents or legal guardians of the participating children filled in a similar FFQ measuring their own food consumption. The parents’ FFQ covered all the foods eaten during the last week. Both parents or legal guardians, should the child have two, were instructed to fill in the parental FFQ. For the analyses, food consumption data was converted into times per week. Paper II used dietary pattern scores derived using principal component analysis (PCA) as outcomes (see Statistical methods for more details).

In paper III, the participating children reported their usual consumption frequency of 23 different food items using a food frequency questionnaire (FFQ) adapted from the Health Behaviour in School-aged Children Survey [113]. Items included in the FFQ were, for instance, fruits and vegetables, beverages, dairy products, snacks, whole grains, meat alternatives and fish. The response options ranged from ‘never’ to ‘more than once a day’ and the reported consumption frequencies were converted into weekly consumption as follows: ‘never’ into 0, ‘less than once a week’ into 0.5, ‘once a week’ into 1, ‘on 2–4 days a week’ into 3, on ‘5–6 days a week’ into 5.5, ‘every day’ into 7, and ‘more than once a day’ into 10 times per week. Dietary pattern scores derived using PCA were used as outcomes in paper III.

## 4.3 ASSESSMENT OF HOME FOOD AVAILABILITY

In paper II, the parents or legal guardians of the participating children reported how often (never, rarely, sometimes, often, always) specified foods were available in their home. The questionnaire has been previously used in the Neighborhood Impact on Kids Study (NIK) [80], and was modified by adding foods and/or drinks considered significant and removing items considered unnecessary to better fit the Finnish context and the objectives of the particular research project. In paper III, the parents or legal guardians reported home food availability using the unmodified questionnaire from the NIK Study. Based on many current dietary guidelines and a presumption that some of the foods are indicative of more health-conscious dietary behaviors, we calculated summary scores describing the availabilities of healthy and unhealthy foods in the home. The food items included in each of the measures are listed in Table 10.

**Table 10.** *Food items included in the measures of healthy and unhealthy home food availability scales in papers II and III.*

| | The DAGIS study (paper II) | The ISCOLE study (paper III) |
|---|---|---|
| **Healthy home food availability** | Fruits and vegetables (range 5–25) | Wholesome foods (range 5–25) |
| | Fresh vegetables | Raw fruit |
| | Fresh fruit | Raw vegetables |
| | Frozen vegetables | 100% fruit juice |
| | Frozen fruit or berries | 1% or fat-free milk |
| | 100% fruit juice | Unsweetened breakfast cereals |
| **Unhealthy home food availability** | Sugar-enriched foods (range 6–30) | Empty-calorie foods (range 8–40) |
| | Sweets, chocolate | Chocolate candy |
| | Sweet cookies | Other candy |
| | Sweet pastries | Cakes, brownies, muffins, cookies |
| | Ice cream | Regular chips or crackers |
| | Sugar-sweetened soft drinks | Juice drinks |
| | Juices with added sugar | Sugar-sweetened soft drinks |
| | | Sports drinks |
| | | Sweetened breakfast cereals |

## 4.4 ASSESSMENT OF SCHOOL FOOD AVAILABILITY

In paper III (the ISCOLE study), trained study staff performed environmental audits in each of the participating schools [111]. The auditors reported the sale of healthy and unhealthy foods in school cafeterias and/or vending machines. Only foods which the children could choose voluntarily were included in the school food availability measures: food items served on school lunch were excluded. Each school was awarded wholesome and empty-calorie food availability scores based on the sell of certain food items (shown in Table 11) in a school cafeteria (1=yes, the food in question could be bought from the school cafeteria, 0=no, the food in question could not be bought from the school cafeteria) or in vending machines (1=yes, the food in question could be bought from vending machines, 0=no, the food in question could not be bought from vending machines).

**Table 11.** *Food items included in the measures of healthy and unhealthy school food availability scales in paper III.*

| | Available in school cafeteria | Available in vending machines |
|---|---|---|
| **Healthy school food availability: wholesome foods (range 0–13)** | 100% fruit or vegetable juice<br>Bread products<br>Fruit (fresh, frozen, canned)<br>Low-fat or skim milk<br>Low-fat or non-fat yogurt<br>Vegetables<br>Lettuce, vegetable or bean salads<br>Water | 100% fruit or vegetable juice<br>Water<br>Trail mix<br>Low-fat or skim milk<br>Nuts |
| **Unhealthy school food availability: empty-calorie foods (range 0–11)** | Chocolate candy<br>Other candy<br>Chips / French fries<br>Biscuits or cookies<br>Ice cream or frozen yogurt<br>Salty snacks<br>Sweetened beverages<br>Savory pastries (pizza etc.) | Chocolate candy<br>Other candy<br>Sweetened beverages |

## 4.5 OTHER VARIABLES AND CONFOUNDING FACTORS

In paper I, the parents or legal guardians reported their educational level using seven response options (comprehensive school; vocational school; secondary school; polytechnic degree; master's degree; licentiate/doctoral degree; other). These categories were then recoded into three levels: secondary school or lower; polytechnic degree; and master's degree or higher. In addition, they reported age and gender of the participating child, the number of children living in the same household as well as both parents' age. The age of the child was recoded into lower than median and higher than median. The number of children living in the same household was recoded into the participating child being the only child in the household; one child in addition to the participating child; and two or more children in addition to the participating child. Furthermore, both of the parents or legal guardians reported how often their family usually gets together for at least one meal on weekdays and weekend days separately. The reported family meal frequencies were converted into weekly frequencies as follows: 'rarely or never' into 0; 'on 1–2 days of the week' into 1.5; 'on 3–4 days of the week' into 3.5; 'every weekday' into 5; 'on one weekend day' into 1; and 'on both weekend days' into 2. The reported weekday and weekend day family meal frequencies were then added together to provide two variables describing the frequency of family meals per week, as reported by father and mother, separately.

## 4.6 STATISTICAL METHODS

### 4.6.1 DIETARY RESEMBLANCE

A multivariate similarity measure [114] for overall food consumption was employed to measure parent-child dietary resemblance in paper I. First, the data was stratified for every unique parent-child pair. The role of variables and observations in the data was then reversed. Instead of the conventional way, Spearman correlation was computed across all the FFQ items for every bivariate observation within a parent-child pair. As a result, a continuous dietary resemblance measure ranging from 0 (no resemblance) to +1 (complete resemblance) incorporating data on all variables measuring food consumption was obtained. In other words, the food items were ranked according to their consumption frequencies separately in the parents' as well as in the children's FFQs. If the food items were ranked identically in a parent's and his/her child's FFQ, a resemblance measure of +1 was yielded, whereas in the unlikely case of "opposite" food consumption, even inverse resemblance could in principle be observed. The resemblance measure is specific for each parent-child pair.

### 4.6.2 DIETARY PATTERN SCORES

*The DAGIS study (paper II)*

Among the DAGIS study sample (paper II), PCA was used to identify existing dietary patterns (IBM SPSS Statistics version 22). All of the 47 FFQ food items were used as input variables, and only children with complete FFQs (N=756, 88% of the participants) were included in the analysis. Based on eigenvalues, a scree plot showing a clear elbow, and the interpretability of the components, three components were chosen. The analysis was then rerun with a forced three-component solution and rotated with an orthogonal Varimax transformation in order to force non-correlation of the components. Standardized dietary pattern scores were calculated for each participant by assigning weights to their frequency of consumption of each food. Bartlett's test of sphericity supported factorability of the data ($\chi^2$=4230.169, df=1081, p<0.001) and the Kaiser-Meyer-Olkin value of 0.618 indicated sampling adequacy.

*The ISCOLE study (paper III)*

To identify dietary patterns in the ISCOLE study sample (paper III), PCA was carried out using version 9.3 of the SAS statistical package for Windows (SAS Institute, Cary, NC, USA, 2011). All but one FFQ food items were used as input variables – fruit juices were excluded from the analyses due to low assessment validity in the FFQ [115]. PCA was performed for each of the 12 study sites separately. Based on the scree plot, which showed a decline with a clear elbow after the second component, two components were chosen and subsequently rotated with an orthogonal Varimax transformation to force non-correlation of the components. Based on the food group loadings, the patterns were named 'unhealthy' and 'healthy' dietary patterns. Standardized dietary pattern scores were calculated for each participant for both dietary patterns by summing the products of a multiplication of optimal regression weights by the participant's food consumption variables [116]. Unhealthy and healthy dietary pattern scores were used as outcome variables in the analyses.

### 4.6.3 SOCIODEMOGRAPHIC FACTORS, FAMILY MEALS AND DIETARY RESEMBLANCE

In paper I, linear mixed models (PROC MIXED of SAS Statistical package version 9.4; SAS Institute Inc., Cary, NC, USA) were used to investigate factors that are potentially associated with parent-child dietary resemblance. Family-specific random intercept terms were introduced to the models in order to take into account the probable familial dependency (each family contributes several observations to the analyses). In univariate models, the father-child and mother-child dietary resemblance measures were used as outcome variables, and child's gender and age, parents' education, number of shared meals, and respondent (the person providing food consumption data on behalf of the child) were used separately as predictor variables. In full models, all predictor variables were entered simultaneously. Parents that were not mothers, fathers, step- or foster parents (n=3) and children whose parents had filled in the child's FFQ together (n=6) were excluded from the analyses. All the participants with sufficient data available were included in each of the analyses (complete case analysis). Basic characteristics of the families with and without sufficient data for the calculation of the dietary resemblance measure were compared using Student's t- and Chi-Squared -tests.

### 4.6.4 FOOD AVAILABILITY AND DIETARY PATTERNS

<u>*The DAGIS study (paper II)*</u>

In paper II, the associations between the home food availability scores and the dietary patterns were examined using multilevel linear mixed methods (PROC MIXED of SAS Statistical package version 9.4; SAS Institute Inc., Cary, NC, USA). Preschools were treated as the highest level in the models in order to take the clustering of the participants due to the preschool-based sampling strategy into account. Because the proportion of children living in the same household was relatively high (the sample included 97 families with two or three participating children), the family-level was used as the middle-level, and individual participants were treated as the lowest level in the three-level models. Since the data was assumed to be nested, i.e. each level to be a subset of the other, one child from a family whose two participating children attended different preschools was excluded from the analyses. Preschools and families nested within them were considered to have fixed effects, and Kenward and Roger approximation was used to calculate the denominator degrees of freedom for statistical test pertaining to fixed effects [117]. The amount of variance in dietary pattern scores in each of the levels (preschools, families and children) was estimated with an unconditional model (intra-class correlation coefficient, ICC). Home food availability scores were categorized into quarters and those with the lowest scores were set as the reference group. Multilevel models were used to examine the associations between home food availability quarters and dietary patterns. First, each of the availability scores were used separately as predictors. Full models with both home food availability scores were used to identify the possible independent roles of the two different dimensions of food availability. Additional models adjusted with gender were run for this thesis in order to make the results of the papers II and III more comparable. Furthermore, the least square means of the dietary pattern scores in different combinations of the home food availability score quarters were calculated to illustrate differences between groups (adjusted for gender). Wald's Z test was used to test the interactions between the availability score categories.

*The ISCOLE study (paper III)*

In paper III, the associations between the food availability scores and dietary patterns were assessed using multilevel linear mixed models (PROC MIXED of SAS Statistical package version 9.3; SAS Institute Inc., Cary, NC, USA). The multilevel modelling was justified by the school-based sampling strategy: the children in the same school are probably more alike than children from different schools. The 12 study sites and the schools nested within the study sites were considered to have fixed effects. The denominator degrees of freedom for statistical tests pertaining to fixed effects were calculated using the Kenward and Roger approximation [117]. The amount of variance in dietary pattern scores in each of the levels (study site, school and children) was estimated with an unconditional model (ICC). Home food availability scores were categorized into quarters and those with the lowest scores were set as the reference group. Schools that did not sell any foods were set as the reference group, and the remaining schools were divided into thirds according to the food availability scores. Crude associations between each of the exposure variables and dietary patterns were investigated with multilevel univariate models adjusted only for gender. The possible independent roles of the food availability variables were examined using multivariable models (additional analyses were run to make the results of the papers II and III more comparable). Additionally, to illustrate the differences between groups, gender-adjusted least square means of the dietary pattern scores in difference combinations of home food availability categories were calculated.

# 5 RESULTS

## 5.1 PARENT-CHILD DIETARY RESEMBLANCE

### 5.1.1 CHARACTERISTICS OF THE PARTICIPANTS

Table 12 presents the descriptive statistics of the children and parents included in the analyses. Sufficient data for the calculation of parent-child dietary resemblance measure was available for 665 (77% of the participating children) father-child and 798 (92%) mother-child-pairs. Compared to the fathers, the mothers were younger and more educated. The participating children were on average 4.74 years old (median 4.75, SD 0.88), and 51% of them were boys. Most of the participating children had one other child living in the same household. Mothers were the predominant informants: they provided food consumption data on behalf of the children in over 90% of the cases.

The dietary resemblance measure was not calculated for 66 participating children due to missing food consumption data. Those children had younger mothers (Student's t-test p=0.029) and less educated parents (Chi-Squared test for both mother's and father's education p<0.0001) compared to the children for whom the resemblance measure was calculated. Additionally, more boys than girls were excluded from the analyses due to missing food consumption data (Chi-Squared test p=0.016). In terms of age of the child or father, number of family meals shared, children living in the same household, or respondent, the excluded children did not differ from the children included in the analyses.

**Table 12.** *Characteristics of the participating children and their parents in paper I.*

| | Sample used to assess father-child resemblance (N=741–798) | Sample used to assess mother-child resemblance (N=617–665) |
|---|---|---|
| Age of the parent, years, mean (SD) | 38.14 (5.46) | 35.67 (4.69) |
| Education of the parent[a], n (%) | | |
| High | 159 (25) | 238 (30) |
| Middle | 224 (35) | 331 (42) |
| Low | 260 (40) | 221 (28) |
| Family meal, days/week, mean (SD) | 5.70 (1.67) | 5.93 (1.57) |
| Gender of the child, n (%) | | |
| Boy | 337 (51) | 408 (51) |
| Girl | 328 (49) | 390 (49) |
| Age of the child, years, mean (SD) | 4.74 (0.88) | 4.74 (0.88) |
| Number of children living in the same household (in addition to the participating child), n (%) | | |
| 0 | 75 (12) | 95 (13) |
| 1 | 347 (56) | 415 (56) |
| 2 or more | 195 (32) | 231 (31) |
| Parent providing food consumption information on behalf of the child (the respondent), n (%) | | |
| Father | 62 (9) | 59 (8) |
| Mother | 596 (91) | 729 (93) |

[a]Highest level of education achieved by the parent, low=secondary school or lower, middle=polytechnic degree, high=master's degree or higher

### 5.1.2 DIETARY RESEMBLANCE IN FAMILIES

Father-child resemblance was on average 0.50 (95% confidence interval 0.48–0.52), whereas mother-child resemblance was 0.57 (0.55–0.58). Mother-child resemblance was significantly stronger than father-child resemblance ($p<0.0001$). The gender of the child was not associated with the amplitude of the parent-child dietary resemblance.

Having mother as a respondent was inversely associated with father-child resemblance and positively associated with mother-child resemblance in the univariate models (Table 13, Figure 8). In other words, if the mother reported food consumption on behalf of the child, father-child resemblance was weaker compared to cases, where food consumption was reported by the father, and vice versa. In the full model, the father-child resemblance was statistically significantly explained only by the respondent: having mother as a respondent was linked to weaker father-child resemblance (Table 14). This tendency for reporter-bias was also seen in the mother-child resemblance. Figure 8 illustrates the reporter-bias observed in paper I.

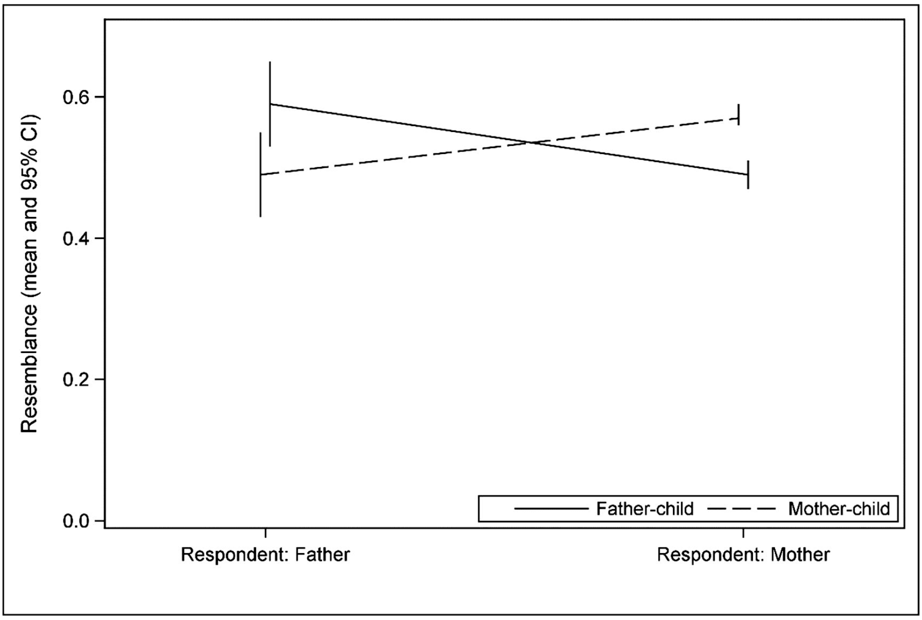


**Figure 8** Illustration of the reporter-bias among father-child and mother-child pairs.

In univariate models, the number of family meals was positively associated with father-child and mother-child resemblance (Table 13). However, in full models with all of the variables entered simultaneously in the models, only mother-reported number of family meals was positively associated with mother-child resemblance (Table 14). Parental educational level was not associated with father-child or mother-child resemblance.

**Table 13.** *Unadjusted univariate models describing the associations between selected variables and father-child and mother-child dietary resemblance, each variable entered separately into the model.*

| | **Father-child resemblance** | | **Mother-child resemblance** | |
|---|---|---|---|---|
| | β estimate | 95% CI | β estimate | 95% CI |
| Gender of the child | | | | |
| Girl | ref. | | ref. | |
| Boy | -0.003 | -0.029, 0.022 | 0.001 | -0.023, 0.025 |
| Age of the child | | | | |
| Median or higher | ref. | | ref. | |
| Lower than median | 0.005 | -0.016, 0.026 | 0.011 | -0.009, 0.030 |
| Number of children in the same household, n (%) | | | | |
| 0 | ref. | | ref. | |
| 1 | 0.002 | -0.036, 0.040 | -0.026 | -0.058, 0.007 |
| 2 or more | 0.003 | -0.036, 0.043 | -0.016 | -0.051, 0.018 |
| Parental[a] educational level[b] | | | | |
| High | ref. | | ref. | |
| Middle | -0.039 | -0.085, 0.008 | -0.015 | -0.056, 0.026 |
| Low | -0.045 | -0.092, 0.001 | -0.034 | -0.080, 0.012 |
| Number of family meals as reported by the parent | 0.014 | 0.003, 0.024 | 0.019 | 0.008, 0.030 |
| Respondent[c] | | | | |
| Father | ref. | | ref. | |
| Mother | -0.068 | -0.129, -0.006 | 0.066 | 0.003, 0.129 |

[a]Parent=father when the outcome is father-child resemblance, parent=mother when the outcome is mother-child resemblance, [b] Highest level of education, low=secondary school or lower, middle=polytechnic degree, high=master's degree or higher, [c]The parent providing food consumption information on behalf of the child

**Table 14.** *Full models explaining father-child and mother-child resemblance, all variables entered simultaneously in the models.*

| | **Father-child resemblance** | | **Mother-child resemblance** | |
|---|---|---|---|---|
| | β estimate | 95% CI | β estimate | 95% CI |
| Gender of the child | | | | |
| Girl | ref. | | ref. | |
| Boy | 0.003 | -0.025, 0.030 | 0.005 | -0.022, 0.032 |
| Age of the child | | | | |
| Median or higher | ref. | | ref. | |
| Lower than median | -0.003 | -0.026, 0.020 | 0.006 | -0.016, 0.028 |
| Number of children in the same household, n (%) | | | | |
| 0 | ref. | | ref. | |
| 1 | 0.002 | -0.037, 0.040 | -0.024 | -0.061, 0.013 |
| 2 or more | 0.004 | -0.037, 0.045 | -0.016 | -0.055, 0.023 |
| Parental[a] educational level[b] | | | | |
| High | ref. | | ref. | |
| Middle | -0.025 | -0.078, 0.028 | 0.004 | -0.044, 0.052 |
| Low | -0.021 | -0.079, 0.037 | -0.020 | -0.078, 0.039 |
| Number of family meals as reported by the parent | 0.003 | -0.014, 0.020 | 0.022 | 0.004, 0.040 |
| Respondent[c] | | | | |
| Father | ref. | | ref. | |
| Mother | -0.090 | -0.162, -0.019 | 0.062 | -0.007, 0.132 |

[a]Parent=father when the outcome is father-child resemblance, parent=mother when the outcome is mother-child resemblance, [b] Highest level of education, low=secondary school or lower, middle=polytechnic degree, high=master's degree or higher, [c]The parent providing food consumption information on behalf of the child

## 5.2 FOOD AVAILABILITY AND DIETARY PATTERNS

### 5.2.1 CHARACTERISTICS OF THE PARTICIPANTS

Altogether 864 Finnish children participated in the DAGIS study (papers I and II), whereas the ISCOLE study (paper III) included the participation of 7372 children from 12 countries. In each of the papers, all participants with sufficient data were included in the analyses. Table 15 presents the basic characteristics of the participants in the DAGIS and ISCOLE studies. In paper II, the home food availability scores were on average 20.4 (SD 2.8) for healthy home food availability (fruits and vegetables availability score, range 5–25) and 16.5 (SD 3.6) for unhealthy home food availability (sugar-enriched foods availability score, range 6–30). For the participants in paper III, the food availability scores were on average 18.0 (SD 4.0) for healthy home food availability (‘wholesome’ food availability score, range 5–25) and 22.4 (SD 5.1) for unhealthy home food availability (‘empty-calorie’ food availability score, range 8–40).

**Table 15.** *Basic characteristics of the participants in the DAGIS (papers I–II) and ISCOLE (paper III) studies.*

| The DAGIS study (N=864) | | | The ISCOLE study (N=7372) | | |
|---|---|---|---|---|---|
| | N | % | | N | % |
| Age, years | | | Age, years | | |
| 3 | 178 | 21 | 9 | 1595 | 22 |
| 4 | 317 | 37 | 10 | 4632 | 63 |
| 5 | 302 | 35 | 11 | 1145 | 16 |
| 6 | 66 | 8 | | | |
| Gender | | | Gender | | |
| Girl | 413 | 48 | Girl | 3950 | 54 |
| Boy | 450 | 52 | Boy | 3422 | 46 |
| Parental education[a] | | | Parental education[b] | | |
| Low | 200 | 23 | Low | 1400 | 20 |
| Middle | 356 | 41 | Middle | 2975 | 43 |
| High | 303 | 35 | High | 2598 | 37 |

[a]Highest level of education achieved by either parent, low=secondary school or lower, middle=polytechnic degree, high=master’s degree or higher, [b]Highest level of education achieved by either parent, low=did not complete high school, middle=completed high school or some college, high=completed Bachelor’s degree or Postgraduate degree

### 5.2.2 DIETARY PATTERNS IN CHILDREN

In paper II (the DAGIS study), altogether 756 preschoolers were included in the PCA, and three dietary patterns explaining 17% of the variance in total were identified. As for the dietary pattern analysis in paper III (the ISCOLE study), two patterns were derived from a sample of 7199 children. The two patterns explained 36% of the variance. In both studies, the strongest pattern identified consisted of food items generally considered unhealthy. Furthermore, these patterns were somewhat similar: in both of the studies, the strongest pattern was characterized by high loadings of, for example, sweets and/or chocolate, ice cream, soft drinks, sweet pastries and potato chips.

Similarly, in both studies, a 'health-conscious' or 'healthy' dietary pattern was identified as the second strongest pattern. These patterns shared some common characteristics: for example, both patterns included high consumption of vegetables; berries; wholegrain cereal products; peas, beans, lentils and soya; eggs; and milk products. Figure 9 illustrates the two strongest dietary patterns in papers II and III. In paper II, a third dietary pattern named 'vegetables-and-processed meats' was also identified. This pattern was characterized by high loadings of, for example, fresh vegetables; cold cuts; fresh fruit; flavored yogurt and quark; and wholemeal bread.

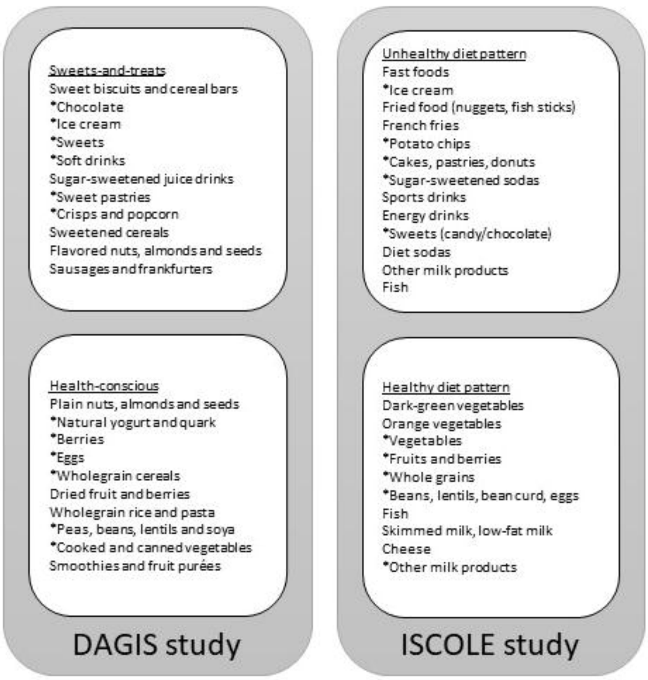


**Figure 9** The food items loading with an absolute value of 0.3 or more to the two strongest patterns identified in the ISCOLE and DAGIS studies. * marks the food items that were fairly similar in the corresponding pattern in both of the studies.

### 5.2.3 HOME FOOD AVAILABILITY

*Univariate models*

In univariate models, unhealthy home food availability was positively associated with the sweets-and-treats pattern in paper II and the unhealthy diet pattern in paper III (Table 16). In addition, unhealthy home food availability was inversely associated with the healthy diet pattern in paper III. Healthy home food availability was positively associated with the health-conscious pattern in paper II as well as with the healthy diet pattern in paper III. Furthermore, healthy home food availability was associated with the vegetables-and-processed meats pattern in paper II.

In paper II, 93% of the variance in the sweets-and-treats pattern scores was attributable to the family level, whereas the corresponding percentages for the health-conscious and vegetables-and-processed meats pattern scores were 92.8% and 90.3%. The variance attributable to the preschool-level was 1.5% for the sweets-and-treats, 3.3% for the health-conscious and 0% for the vegetables-and-processed meats pattern scores. In paper III, 7.8% of the variance in the unhealthy diet pattern was on school-level, whereas the corresponding percentage for the healthy diet pattern was 4.0%. Regarding both of the patterns, the rest of the variance was attributable to individual level.

*Full models*

The full models with both home food availability variables (unhealthy and healthy) are presented in Table 17. In both papers, unhealthy home food availability was positively and healthy home food availability inversely associated with the strongest pattern (sweets-and-treats pattern in paper II and unhealthy diet pattern in paper III). The β estimates were stronger for the unhealthy home food availability scores suggesting that in case of an unhealthy dietary pattern, the availability of unhealthy foods is more important than the availability of healthy foods in the home.

In paper II, healthy home food availability was positively associated with the health-conscious pattern. Unhealthy home food availability was inversely associated with the health-conscious pattern, but the association became significant only in the highest quarter of unhealthy home food availability. In paper III, the availability of unhealthy foods was inversely and that of healthy foods positively associated with the healthy diet pattern. In paper II, the availability of healthy foods in the home was positively associated with the vegetables-and-processed meats pattern.

**Table 16.** *Univariate models describing the associations between unhealthy and healthy home food availabilities and dietary patterns in papers II and III.*

| | | **Sweets-and-treats pattern** (paper II) | | **Unhealthy diet pattern** (paper III) | |
|---|---|---|---|---|---|
| | | β estimate | 95% confidence interval | β estimate | 95% confidence interval |
| Unhealthy home food availability[a,b], quarters | 1[c,d] | ref. | | ref. | |
| | 2 | 0.32 | 0.11, 0.53 | 0.11 | 0.04, 0.18 |
| | 3 | 0.49 | 0.25, 0.72 | 0.26 | 0.20, 0.33 |
| | 4 | 0.92 | 0.70, 1.14 | 0.44 | 0.37, 0.51 |
| Healthy home food availability[e,f], quarters | 1[g,h] | ref. | | ref. | |
| | 2 | -0.11 | -0.34, 0.12 | -0.09 | -0.16, -0.02 |
| | 3 | -0.06 | -0.28, 0.15 | -0.08 | -0.15, -0.02 |
| | 4 | 0.01 | -0.22, 0.23 | -0.20 | -0.27, -0.12 |
| | | **Health-conscious pattern** (paper II) | | **Healthy diet pattern** (paper III) | |
| | | β estimate | 95% confidence interval | β estimate | 95% confidence interval |
| Unhealthy home food availability[a,b], quarters | 1[c,d] | ref. | | ref. | |
| | 2 | 0.03 | -0.18, 0.24 | -0.06 | -0.13, 0.01 |
| | 3 | -0.03 | -0.26, 0.20 | -0.12 | -0.18, -0.05 |
| | 4 | -0.09 | -0.31, 0.13 | -0.16 | -0.23, -0.08 |
| Healthy home food availability[e,f], quarters | 1[g,h] | ref. | | ref. | |
| | 2 | 0.16 | -0.05, 0.38 | 0.19 | 0.12, 0.26 |
| | 3 | 0.28 | 0.08, 0.48 | 0.18 | 0.12, 0.25 |
| | 4 | 0.46 | 0.25, 0.67 | 0.30 | 0.23, 0.38 |

| | | **Vegetables-and-processed meats pattern** (paper II) | |
|---|---|---|---|
| | | β estimate | 95% confidence interval |
| Unhealthy home food availability[a,b], quarters | 1[c,d] | ref. | |
| | 2 | 0.02 | -0.20, 0.24 |
| | 3 | -0.17 | -0.04, 0.08 |
| | 4 | -0.05 | -0.28, 0.18 |
| Healthy home food availability[e,f], quarters | 1[g,h] | ref. | |
| | 2 | 0.31 | 0.08, 0.54 |
| | 3 | 0.30 | 0.09, 0.51 |
| | 4 | 0.36 | 0.14, 0.59 |

[a]Composite score consisting of the availability frequencies of sweets and chocolate; sweet cookies; sweet pastries; ice cream; soft drinks; and juices with added sugar in the home (paper II), [b]Composite score consisting of the availability frequencies of chocolate candy; other candy; cakes, brownies, muffins or cookies; regular chips or crackers; juice drinks; soft drinks; sports drinks; and sweetened breakfast cereals in the home (paper III), [c]Quarters of unhealthy home food availability score in paper II (ranges 8–13; 14–16; 17–18; 19–28); [d]Quarters of unhealthy home food availability score in paper III (ranges 8–18; 19–21; 22–24; 25–40); [e]Composite score consisting of the availability frequencies of fresh vegetables; fresh fruit; frozen vegetables; frozen fruit or berries; and 100% fruit juice in the home (paper II), [f]Composite score consisting of the availability frequencies of raw fruit; raw vegetables; 100% fruit juice; 1% or fat-free milk; and unsweetened breakfast cereals in the home (paper III), [g]Quarters of healthy home food availability score in paper II (ranges 11–18; 19–20; 21–22; 23–25), [h]Quarters of healthy home food availability score in paper III (ranges 5– 14; 15–17; 18–20; 21–25). All models adjusted for gender.

**Table 17.** *Full models (both unhealthy and healthy home food availability entered simultaneously in the models) describing the associations between unhealthy and healthy home food availabilities and dietary patterns in papers II and III.*

| | | **Sweets-and-treats pattern** (paper II) | | **Unhealthy diet pattern** (paper III) | |
|---|---|---|---|---|---|
| | | β estimate | 95% confidence interval | β estimate | 95% confidence interval |
| Unhealthy home food availability[a,b], quarters | 1[c,d] | ref. | | ref. | |
| | 2 | 0.36 | 0.15, 0.57 | 0.12 | 0.05, 0.19 |
| | 3 | 0.54 | 0.30, 0.77 | 0.28 | 0.21, 0.34 |
| | 4 | 1.03 | 0.80, 1.26 | 0.47 | 0.40, 0.54 |
| Healthy home food availability[e,f], quarters | 1[g,h] | ref. | | ref. | |
| | 2 | -0.23 | -0.45, -0.01 | -0.13 | -0.20, -0.06 |
| | 3 | -0.27 | -0.48, -0.06 | -0.14 | -0.21, -0.08 |
| | 4 | -0.31 | -0.53, -0.08 | -0.26 | -0.34, -0.19 |
| | | **Health-conscious pattern** (paper II) | | **Healthy diet pattern** (paper III) | |
| | | β estimate | 95% confidence interval | β estimate | 95% confidence interval |
| Unhealthy home food availability[a,b], quarters | 1[c,d] | ref. | | ref. | |
| | 2 | -0.02 | -0.23, 0.19 | -0.07 | -0.14, -0.00 |
| | 3 | -0.11 | -0.34, 0.13 | -0.14 | -0.21, -0.07 |
| | 4 | -0.26 | -0.49, -0.04 | -0.19 | -0.27, -0.12 |
| Healthy home food availability[e,f], quarters | 1[g,h] | ref. | | ref. | |
| | 2 | 0.18 | -0.04, 0.40 | 0.21 | 0.13, 0.28 |
| | 3 | 0.33 | 0.13, 0.53 | 0.21 | 0.14, 0.28 |
| | 4 | 0.54 | 0.32, 0.76 | 0.34 | 0.26, 0.42 |

| | | **Vegetables-and-processed meats pattern** (paper II) | |
|---|---|---|---|
| | | β estimate | 95% confidence interval |
| Unhealthy home food availability[a,b], quarters | 1[c,d] | ref. | |
| | 2 | -0.03 | -0.25, 0.19 |
| | 3 | -0.23 | -0.48, 0.02 |
| | 4 | -0.18 | -0.42, 0.05 |
| Healthy home food availability[e,f], quarters | 1[g,h] | ref. | |
| | 2 | 0.36 | 0.12, 0.59 |
| | 3 | 0.37 | 0.15, 0.58 |
| | 4 | 0.45 | 0.22, 0.68 |

[a]Composite score consisting of the availability frequencies of sweets and chocolate; sweet cookies; sweet pastries; ice cream; soft drinks; and juices with added sugar in the home (paper II), [b]Composite score consisting of the availability frequencies of chocolate candy; other candy; cakes, brownies, muffins or cookies; regular chips or crackers; juice drinks; soft drinks; sports drinks; and sweetened breakfast cereals in the home (paper III), [c]Quarters of unhealthy home food availability score in paper II (ranges 8–13; 14–16; 17–18; 19–28); [d]Quarters of unhealthy home food availability score in paper III (ranges 8–18; 19–21; 22–24; 25–40); [e]Composite score consisting of the availability frequencies of fresh vegetables; fresh fruit; frozen vegetables; frozen fruit or berries; and 100% fruit juice in the home (paper II), [f]Composite score consisting of the availability frequencies of raw fruit; raw vegetables; 100% fruit juice; 1% or fat-free milk; and unsweetened breakfast cereals in the home (paper III), [g]Quarters of healthy home food availability score in paper II (ranges 11–18; 19–20; 21–22; 23–25), [h]Quarters of healthy home food availability score in paper III (ranges 5– 14; 15–17; 18–20; 21–25). All models adjusted for gender.

Concerning the strongest patterns (sweets-and-treats and unhealthy), those with the highest unhealthy home food availabilities scored highest (Figure 10). The participants with high availability of healthy foods in the home scored lower on the sweets-and-treats as well as unhealthy patterns, but if there were plenty of unhealthy foods were available in the home, the participants scored higher regardless of the availability of healthy foods in the home.

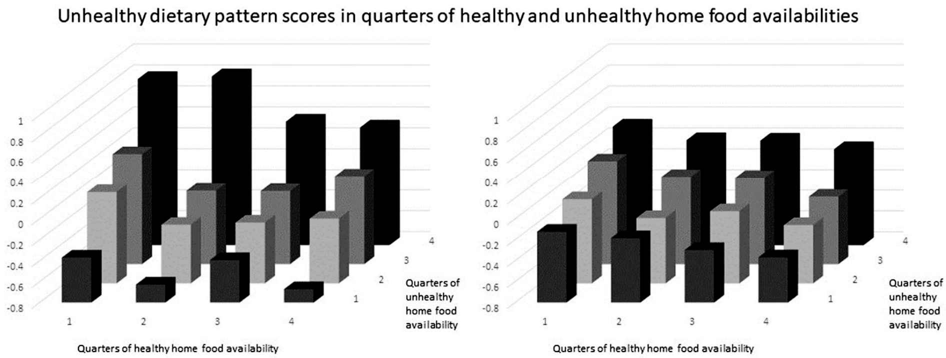


**Figure 10** Unhealthy dietary pattern scores in papers II (left panel) and III (right panel) in the quarters of healthy (horizontal axis; 1=first quarter etc.) and unhealthy (vertical axis; 1=first quarter etc.) home food availabilities.

Regarding the second strongest patterns (health-conscious and healthy), those with the highest healthy food availabilities scored highest (Figure 11). However, the participants in the highest quarter of both healthy and unhealthy home food availabilities scored lower compared to the participants in the highest healthy and lowest unhealthy home food availabilities, i.e., the availability of unhealthy foods in the home was associated with lower health-conscious or healthy pattern scores even though the availability of healthy foods in the home was high.

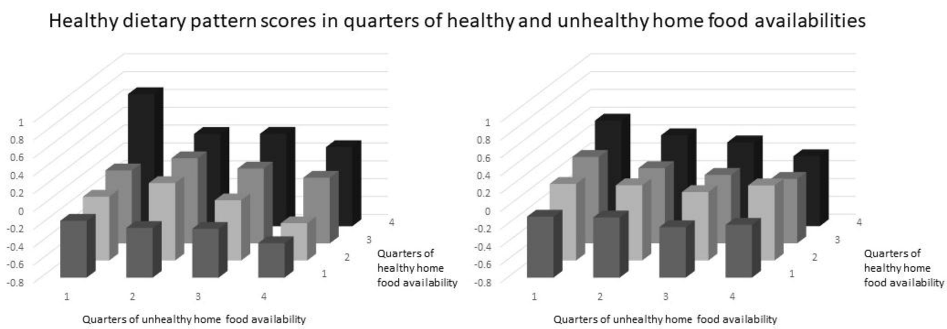


**Figure 11** Healthy dietary pattern scores in papers II (left panel) and III (right panel) in the quarters of unhealthy (horizontal axis; 1=first quarter etc.) and healthy (vertical axis; 1=first quarter etc.) home food availabilities.

### 5.2.4 SCHOOL FOOD AVAILABILITY

In paper III, the associations between unhealthy and healthy food availability in the school and dietary patterns among 9–11-year-olds were examined. Table 18 presents the availabilities of unhealthy and healthy foods in schools stratified by study site. Of the participating schools, 50% did not sell food in the canteen, cafeteria or in the vending machines (except for school lunch). The percentages of schools selling foods were highest in Portugal, South Africa and Colombia, whereas no foods were sold in the Canadian nor Chinese schools. On average, the availability scores were higher for the unhealthy foods compared to the healthy foods. However, schools in Australia, Finland, Portugal and the UK scored higher on the healthy food availability compared to the unhealthy food availability.

**Table 18.** *Unhealthy and healthy school food availability scores and number of schools not selling foods by study site*

| Site | Number of schools | Unhealthy school food availability score[a] | Healthy school food availability score[b] | Number of schools not selling foods (%) |
|---|---|---|---|---|
| Australia (Adelaide) | 26 | 5.5 (2.0) | 4.1 (1.5) | 6 (23) |
| Brazil (São Paulo) | 24 | 2.9 (2.5) | 4.7 (2.7) | 12 (50) |
| Canada (Ottawa) | 26 | 0 (0) | 0 (0) | 26 (100) |
| China (Tianjin) | 6 | 0 (0) | 0 (0) | 6 (100) |
| Colombia (Bogotá) | 20 | 3.5 (2.2) | 7.5 (1.0) | 1 (17) |
| Finland (Helsinki, Espoo, Vantaa) | 25 | 4.9 (1.5) | 3.0 (0.6) | 18 (72) |
| India (Bangalore) | 10 | 2.5 (1.1) | 6.1 (1.8) | 2 (20) |
| Kenya (Nairobi) | 29 | 1.4 (1.1) | 3.4 (2.3) | 19 (66) |
| Portugal (Porto) | 23 | 5.5 (1.7) | 4.7 (1.5) | 0 (0) |
| South Africa (Cape Town) | 20 | 0.8 (1.2) | 4.4 (1.5) | 2 (10) |
| United Kingdom (Bath) | 26 | 2.5 (1.4) | 0.9 (1.1) | 18 (69) |
| United States of America (Baton Rouge) | 21 | 0 (0) | 3.5 (0.7) | 19 (90) |
| All | 256 | 3.5 (2.5) | 4.6 (2.2) | 129 (50) |

[a]Composite score consisting of the availability of chips; biscuits or cookies; ice cream or frozen yogurt; salty snacks; savory pastries; chocolate; other candy; and sweetened beverages in school cafeteria or vending machines, range 0–11, [b]composite score consisting of the availability of 100% fruit or vegetable juice; bread products; fruits; low-fat or skim milk; low-fat or non-fat yogurt; vegetables; lettuce, vegetable or bean salads; water; trail mix; and nuts in school cafeteria or vending machines, range 0–13

In univariate model, the availability of unhealthy foods in the school was not associated with the unhealthy diet pattern (Table 19). Similarly, the availability of healthy foods in the school was not associated with the unhealthy diet pattern. The availabilities of unhealthy or healthy foods in the school were not associated with the healthy diet pattern either. The results remained fairly similar in the multivariable models, where both of the school food availability variables were entered simultaneously in the model.

**Table 19.** *Univariate and full models describing the associations between school food availability and dietary patterns in paper III.*

| | | Univariate models: all variables entered separately | | Full models: both variables entered simultaneously | |
|---|---|---|---|---|---|
| **Unhealthy diet pattern** | | | | | |
| | | β estimate | 95% confidence interval | β estimate | 95% confidence interval |
| Unhealthy school food availablility[a], thirds | No shops[b] | ref. | | ref. | |
| | 1 | -0.09 | -0.24, 0.05 | -0.05 | -0.22, 0.11 |
| | 2 | -0.02 | -0.13, 0.10 | 0.01 | -0.13, 0.14 |
| | 3 | -0.03 | -0.16, 0.11 | 0.02 | -0.14, 0.19 |
| Healthy school food availability[c], thirds | No shops[d] | ref. | | ref. | |
| | 1 | 0.06 | -0.11, 0.22 | 0.07 | -0.12, 0.27 |
| | 2 | -0.09 | -0.21, 0.04 | -0.10 | -0.25, 0.06 |
| | 3 | 0.00 | -0.12, 0.11 | 0.00[e] | |
| **Healthy diet pattern** | | | | | |
| | | β estimate | 95% confidence interval | β estimate | 95% confidence interval |
| Unhealthy school food availablility[a], thirds | No shops[b] | ref. | | ref. | |
| | 1 | -0.03 | -0.15, 0.08 | 0.00 | -0.14, 0.14 |
| | 2 | -0.06 | -0.15, 0.04 | -0.07 | -0.18, 0.04 |
| | 3 | 0.01 | -0.09, 0.12 | 0.00 | -0.13, 0.14 |
| Healthy school food availability[c], thirds | No shops[d] | ref. | | ref. | |
| | 1 | -0.03 | -0.17, 0.11 | -0.01 | -0.17, 0.15 |
| | 2 | 0.01 | -0.09, 0.11 | 0.02 | -0.11, 0.14 |
| | 3 | -0.03 | -0.13, 0.06 | 0.00[e] | |

[a]Composite score consisting of the availability of chips; biscuits or cookies; ice cream or frozen yogurt; salty snacks; savory pastries; chocolate; other candy; and sweetened beverages in school cafeteria or vending machines, [b]schools selling no food at all used as reference group, the rest of the schools divided into thirds

based on the unhealthy school food availability score (ranges 1–3, 4–6, 7–10), [c]composite score consisting of the availability of 100% fruit or vegetable juice; bread products; fruits; low-fat or skim milk; low-fat or non-fat yogurt; vegetables; lettuce, vegetable or bean salads; water; trail mix; and nuts in school cafeteria or vending machines, [d]schools selling no food at all used as reference group, the rest of the schools divided into thirds based on the healthy school food availability score (ranges 1–2, 3–5, 6–8), [e]Not enough statistical power to produce an estimate

# 6 DISCUSSION

## 6.1 MAIN FINDINGS

Based on the literature review, the social and physical home food environments seem to be related to children's food consumption. However, most of the earlier studies have focused on the consumption of certain foods or food groups. In this thesis, a more comprehensive whole-diet approach was applied. The results of this thesis suggested that the diets of the preschoolers and their parents were largely similar. Mother-child resemblance seemed to be stronger than father-child resemblance, but a significant parent-respondent interaction was also found: the diet of the child resembled more the diet of the parent who provided the responses for the child. After taking the reporter-bias into account, father-child and mother-child resemblances did not differ from each other. Additionally, the number of family meals was positively associated with mother-child resemblance. Parent-child resemblance was similar across all parental educational levels.

The availability of unhealthy foods in the home was positively associated with dietary patterns generally regarded as unhealthy. Furthermore, the availability of healthy foods in the home was inversely associated with the aforementioned dietary patterns. In paper III, the availability of unhealthy foods in the home was inversely and that of healthy foods positively associated with healthy diet pattern, whereas in paper II, the availability of healthy foods in the home was positively associated with health-conscious and vegetables-and-processed meats dietary patterns. School food availability was not associated with unhealthy or healthy diet pattern.

## 6.2 METHODOLOGICAL CONSIDERATIONS

### 6.2.1 PARTICIPANTS

The participants in papers I and II were from eight Finnish municipalities which were selected based on SES indicators. Thus, the participants represented regionally a large part of Southern and Western Finland and were from different socioeconomic backgrounds. However, some selection bias was detected: in paper I, 60% of the fathers and 72% of the mothers had polytechnic degree or higher education, whereas the corresponding percentage among the Finnish population is only 30% [118]. Moreover, the fathers who provided food consumption information on behalf of their children were more educated than the fathers whose children's food consumption was reported by their mothers. Thus, the results of paper I can only be generalized to Finnish preschoolers with precaution. Regarding paper II, as socioeconomic status may, for example, be associated with home food availability [119], the results may not be generalizable to those with lower education. Nevertheless, in paper II, the results were rather similar with and without adjustment for highest education in the family [120].

Participants in paper III were from 12 culturally and economically different countries from all around the world. In terms of BMI, physical activity and screen time, the ISCOLE data did not seem to be systematically biased [121]. However, the participants were from urban and semi-urban areas from one study site (in some cases including two or three municipalities) in each of the countries, and thus, appropriate caution should be used when generalizing the results. Still, the large sample size and global setting makes the results reasonably reliable and extends the conclusions to countries of very different developmental level, culture and geographical location.

In papers II and III, multi-level analyses were used to take into account the sampling strategy, which was performed based on school classes and preschools. In paper II, only a small amount of variance in dietary pattern scores was attributable to the preschool-level, whereas in paper III, the corresponding percentage was somewhat larger. This is not surprising, since the FFQ used in paper II measured foods eaten outside preschool hours, whereas the children in paper III reported also foods eaten at school. Still, families living in the same area may share similar food practices and/or consumption norms that may influence the diet of the children. The preschools and schools can also affect the children's food consumption in the home through education and social norms offered by the teachers and early educators. Especially among school-aged children, food behavior may also be affected by peers [122].

### 6.2.2 DESIGNS

All of the studies were conducted by using a cross-sectional design. Thus, causality cannot be judged. In paper I, for example, it is not clear, if the diet of the child has adapted to the diet of the parent, or the other way around. Some studies have showed that maternal food consumption, as measured 2–7 years earlier, predicted the diet of their children later on [51, 52, 54]. However, only one of these studies adjusted for child's food consumption in the baseline [52]. Thus, the direction of the possible causality cannot be judged based on the studies conducted so far, and more longitudinal studies are needed.

It would be reasonable to assume that children eat what their parents have bought to the home. This is especially true in paper II, where the children were preschool-aged and not able to consume foods without an adult. However, as Ventura & Birch have stated, parenting is interactive and includes also reactions to child characteristics [123]. Thus, parents do not only affect the diets of their children: children can also have an effect on their parents' food purchases [124]. It has also been shown, that preschool-aged children can initiate food requests while shopping with a parent [125]. According to a US study, these requests could mainly be labeled as 'unhealthy' or 'neutral' [126].

### 6.2.3 DIETARY ASSESSMENT METHODS

In papers I and II, the same 47-item FFQ was used to measure food consumption among preschool children. The FFQ was designed for the DAGIS study, since no culturally appropriate FFQs measuring the consumption of vegetables, fruits and berries as well as sugar-enriched foods, which were the main interests in the project, were available. The validity of the FFQ is not yet known. The FFQ was intentionally restricted to measure food consumption outside preschool hours for two reasons: 1) most of the variance in the diets of Finnish preschool children are probably due to foods eaten at home (catering in the preschools is municipally organized and is instructed on a national level [112]) and 2) the parents would not have been able to assess the foods their children had eaten at preschool.

In paper I, a similar FFQ was used to measure food consumption among the parents of the participating children. In contrast to the children's FFQ, the parents were asked to report foods consumed also outside home (for example at work during days). Since the children's food consumption was measured only outside preschool hours, it is possible that the observed resemblance measure was stronger than it may actually be. However, the extent of the possibly overestimated resemblance is probably common to all participating children, as the preschool meals within the same municipality are produced by a single catering company. Hence, it is likely that this gap in assessment of food consumption has little effect on the ranking of the food items and the subsequent analyses. The validity of the FFQ among adults is not known.

In paper III, a validated 23-item FFQ was used to measure food consumption among the children. According to the validation study [115], some misreporting based on social desirability was observed. For most food groups, however, percentage of gross misclassification was below 5% and systematic misreporting was not observed. In addition, due to low validity, the item 'fruit juice' was removed from the data before the PCA. The participating children completed the FFQ themselves, which probably increased the validity of the FFQ: it has been suggested that the food intake of 8–11-year-olds can report their own food intake more accurately than their parents [127]. Additionally, the parents would not have been able to assess the foods the children had eaten during school days.

Instead of using an FFQ to measure diet in papers I–III, food records or 24h recalls could have been used. However, since the aforementioned methods are both burdensome for the participants and require a lot of resources from the research staff, FFQ was chosen. In addition, since food records or 24h recalls are only able to capture food consumption on a few days, they may not be ideal methods to be used as input for dietary patterns, which are usually thought of describing a person's diet on a more general level [128].

### 6.2.4 USE OF WHOLE-DIET APPROACH

In paper I, a novel method assessing the whole diet of the participants was used. Since the method was based on Spearman correlations, the absolute food consumption frequencies were not of importance as long as the possible misreporting did not interfere with the within-individual ranking of the food items. For the method to be applicable in assessing the parent-child resemblance, the FFQs of the parents and children had to be identical. However, it is not known if the parents misreport differently when filling in the FFQ for the child compared to when filling in the FFQ for themselves. Thus, it is possible that the rankings in the child's and parent's FFQs were differently affected by misreporting.

Compared to traditional approach focusing on single nutrients or foods, the use of data-driven analyses of dietary patterns represent a broader picture of food consumption and can enhance our understanding of dietary behavior [129]. Furthermore, the empirical approaches do not depend on the researchers' definition of a healthful pattern but are based on intercorrelations between food items (PCA) [130]. However, the use of dietary patterns has its own pitfalls, too. For example, the food items present in the FFQ and their grouping before the analysis affects the patterns extracted [131]. In addition, PCA requires multiple subjective decisions that are rarely reported in detail making the procedure challenging to review and compare. Furthermore, since PCA is based on the correlations between the consumption frequencies of different foods, it requires interpretation of the extracted component.

The extraction of dietary patterns is susceptible to many subjective decisions, and thus, several different results are possible and acceptable. The use of dietary assessment method, for example, may have an effect on the patterns identified. Food items not included in the FFQs in papers II and III, could not load to any of the patterns identified. Another issue worth discussing is the labelling of the patterns. Furthermore, patterns with different names can have corresponding contents, and vice versa, and patterns labelled similarly can include foods that do not resemble each other. Moreover, the naming of the patterns is often theory-based: 'healthy' patterns consist of foods generally regarded as healthy, but their actual associations with health outcomes are only seldom investigated.

In addition to PCA, dietary patterns can also be extracted using other methods. Cluster analysis, for example, is based on individual differences in mean intakes and classifies the participants into clusters [130]. Another, fairly modern technique is reduced rank regression (RRR), which uses both empirical data as well as prior knowledge and is thus, so to speak, a mix of an exploratory (data-driven) and a hypothesis-oriented approach [132]. However, since RRR is based on the associations of foods and diseased-related nutrients or biomarkers [133], the method could not be used in this thesis. PCA was chosen over cluster analysis, since it allows an analysis of several patterns instead of categorizing each of the participants into one cluster. However, since PCA has been widely used, the extracted components usually are very much alike, which facilitates the comparison of the results.

Since data-driven dietary pattern scores were used as outcomes in papers II and III, the effect of the possible misreporting in the FFQs is not likely to be substantial. However, especially under-reporting may attenuate of possible associations between the exposure and the outcome [134]. In paper III, the FFQ used only measured the consumption frequency of 23 foods. Thus, it is possible that some frequently used foods were missing from the PCA and the identified dietary patterns are not comprehensive. Although the FFQs used in the studies did not assess the amounts of each food eaten, it has been shown that meaningful dietary patterns can be identified using simple methods such as binary food consumption data (consumed/not consumed) [135].

### 6.2.5 FOOD AVAILABILITY ASSESSMENTS

In papers II and III, home food availability was measured using a parent-reported questionnaire. For paper II, the home food availability questionnaire was modified by adding foods and/or drinks considered significant and removing items that were considered to be unnecessary. The questionnaire has been used previously in the Neighborhood Impact on Kids (NIK) Study [80], but the validity of the questionnaire is unknown. Interestingly, the scale used to measure the availability of high-energy/nutrient-poor foods in the NIK Study consisted of the same food items than the unhealthy home food availability score used in paper III. Fairly similar results were also obtained in the NIK study compared to paper III: in the NIK study, the availability of unhealthy foods was inversely associated with DASH score among 6–11-year-olds [80].

The healthy home food availability scores, however, were somewhat different in the NIK study as compared to paper III: whereas the NIK Study included the availability of raw fruits; baked chips, low-fat crackers or pretzels; raw vegetables; and unsweetened cereals, in paper III, raw fruits; raw vegetables; 100% fruit juice; 1% or fat-free milk; and unsweetened cereals were included in the wholesome home food availability score. Regardless of the incongruity in the healthy home food availability scales, results were along the same lines in both studies: healthy home food availability was positively associated with DASH score in the NIK study [80].

Home food availability could have also been measured using a home food availability inventory checklist (see for example [136]). However, the checklists only measure current availability, whereas in papers II and III, the aim was to measure usual availability of certain foods. Although the home food availability scales used in papers II and III were not validated, they had acceptable Cronbach's alphas (0.62–0.72) suggesting at least some reliability [137]. Nevertheless, even though the measures seemed to be reliable, their validity remains unknown [138]. The gold standard method, researcher observation, would have been impossible to carry out because of the costs.

School food availability in paper III was measured by observational analyses, which were performed by trained research assistants. Only handful of studies have examined the associations between school food availability and diet in children, and the methods used in the assessment of school food availability have varied. Most of the studies have used headmaster- or cafeteria staff -reported information (e.g., fruit and vegetables subscription programs or food inventories) [72, 73, 108]. Compared to the aforementioned studies, the method in paper III was rigorous and the results can be considered to be more reliable. However, more studies assessing school food availability and its association with diet are needed.

## 6.3 INTERPRETATION OF THE RESULTS

### 6.3.1 DIETARY RESEMBLANCE

In paper I, the diets of the parents and their children were fairly similar, regardless of the socioeconomic background, as demonstrated by the moderate resemblance measures. A reporter-bias suggesting that the diet of the child was more similar to the diet of the parent who filled in the FFQ on behalf of the child, was also detected. This phenomenon has previously been discussed by Oliveria et al., Shrivastava et al., and Freitas-Vilela et al. [38, 139, 140]. It is possible that mothers, who have traditionally provided the food intake information on behalf of their children [141], are more willing to report their child's food consumption because they are more aware of the child's diet. Mothers have, for example, reported greater feeding responsibility compared to fathers [142].

Eating together as a family gives the child opportunities to assimilate and model health behaviors, such as healthy or unhealthy food consumption. In paper I, the frequency of family meals was positively associated with mother-child, but not with father-child dietary resemblance. It is possible that mothers and father have interpreted the survey question "How often your family usually gets together for at least one meal?" differently. Other studies have also reported conflicting results. For example, in a recent European study, the odds of being allocated to the same dietary pattern with the father was higher with more meals shared, whereas no such association was found between mothers and children [60]. In a US study, the frequency of parents' eating at home was not associated with parent-child correlations in dietary intake except for mother-child resemblance in cholesterol intake [38].

The method used in paper I did not take a stand on the healthiness of the children's or parents' diets. However, a large European study recently suggested that parent-child correlations in healthy food consumption are slightly stronger compared to correlations in unhealthy food consumption [37]. Thus, the novel method used in paper I could be further developed to produce two separate parent-child resemblance measures: healthy and unhealthy. The two measures could then be compared in order to examine, if parent-child resemblance is stronger in unhealthy or healthy food behavior.

### 6.3.2 FOOD AVAILABILITY AND DIETARY PATTERNS

Despite the challenges described in chapter 6.2.4, quite commonly, two patterns, often labelled as 'prudent' ('healthy') and 'Western' ('unhealthy'), are identifiable among adult populations [143]. Similarly, according to a systematic review by Smithers et al., the most frequently emerging patterns among preschool-aged children are 'healthy', 'unhealthy' and 'traditional' patterns [144]. 'Healthy' or 'health-conscious' as well as 'traditional' or 'Western' patterns have also been identified among school-aged children from different cultural backgrounds [145-147].

In paper II, the third dietary pattern identified was of mixed nature: it contained traits of both healthy and unhealthy diets. Although the mixed nature of the pattern complicates the labelling, it can depict the diet of the children truthfully - people's diets are seldom purely healthy or unhealthy, but rather a combination of those two dimensions. The pattern was named 'vegetables-and-processed meats' based on the food items loading most strongly to the pattern. Mixed patterns of the same kind have been also identified in other studies [148-150].

*Home food availability*

In papers II and III, the availability of unhealthy foods in the home was associated with unhealthy dietary pattern even when there were also healthy foods available in the home. One study with a similar finding was identified through the literature search: among school-aged Australian girls, fruit and vegetable availability in the home was inversely and that of non-core foods positively associated with sweetened drink intake [88]. In four studies, the availability of unhealthy foods but not that of healthy foods was positively associated with unhealthy diet (soft drink / sweetened drink or fats and/or sweets consumption) [79-82]. Correspondingly, the availability of healthy foods in the home was positively and that of unhealthy foods inversely associated with healthy dietary patterns in papers II and III. A similar result with DASH score as the outcome has also been obtained in a sample of US children [80]. However, none of the other studies that have included both dimensions of home food availabilities in the same model have reported an inverse association between unhealthy home food availability and healthy diet (fruit and/or vegetable intake) [79, 81, 82].

Since smaller children can only eat what is available in the home, parents have the possibility to influence the diets of their children by controlling the home food availability [27]. In school-aged children, it is of course not clear if the children consumed unhealthy foods on their own or as part of the meals prepared and/or served by parents, but the preschool-aged children are much more dependent on their parents' decisions. Still, quite similar results were obtained in papers II and III suggesting that the associations between home food availability and dietary patterns are fairly robust in pre- and primary school –aged children.

Home food availability reflects the choices of the parents, albeit it can be influenced by the children, as discussed earlier. Home food availability, but also food environment on a larger scale (consumer food environment) has been shown to be associated with dietary behavior also among adult population [151, 152]. Still, it may be that the capabilities of adults and children in resisting temptations, such as highly palatable foods, may be of different level. It has, in fact, been shown that although both adults and children were visually attracted to unhealthy foods, adults, but not children, were able to shift their attention away from unhealthy foods [153].

The roles of the physical and social home food environments are probably interdependent: parents who eat a lot of vegetables, for example, can be speculated to buy more vegetables to their home (high availability) compared to parents who do not eat vegetables. Thus, it is not possible to perfectly distinguish the physical and social aspects of home food environment from each other. Many studies have, in fact, made an effort to measure both of these aspects.

*School food availability*

Not many studies have investigated the associations between school food availability and diet of the pupils, and the studies conducted have yielded conflicting results. Similar to the results obtained in paper III, the availability of foods in the school was not associated with dietary outcomes in a Norwegian sample [105]. However, having both fruits and vegetables as well as unhealthy foods available in the school was associated with increased odds of having a higher fruit and vegetable intake among Danish boys, but not among girls [72].

There are several reasons that may explain the lack of associations and conflicting findings. First, most children have only one or two eating occasions at school, and the major part of the foods are consumed outside the school. Furthermore, the policies regarding school lunch are diverse. In some countries and schools, the pupils bring a packed lunch to the school thus extending the impact of home food availability into the school. The schools in the 12 countries may also restrict the selling of unhealthy foods differently or have other divergent policies. In addition, in paper III, only 127 schools (50% of the participating schools) sold any foods at all, which might have affected the results. Finally, school food availability was measured as the sell of certain foods in the schools. The results might have been different, if the availability measures had included foods which the pupils could eat free of charge. The amount of money the participants had for their own use was not assessed.

In paper III, the children were 9–11-year-olds and thus capable of making their own decisions concerning foods consumed at school or in the vicinity of school. The school-aged children can also, at least in some countries, leave the school premises to buy food items outside school. It has been suggested that the neighborhood surrounding school might be associated with the students' diet. For example, in a Canadian study, students attending a school with three or more fast-food outlets within 1 km radius from the school had lower HEI scores compared to students attending a school with no fast-food outlets near the school [154]. Conflicting results have been obtained: in a New Zealand study, the density of cafes and restaurants, supermarkets and takeaway outlets was positively associated with dietary quality among boys, but not among girls [155]. However, the distance between school and a food outlet may not be the best measure to describe neighborhood food environment: it could be more accurate to measure the number of food outlets on an actual route of a pupil.

## 6.4 IMPLICATIONS FOR FUTURE STUDIES

Sociocultural factors, such as role modelling, have been shown to be consistently associated with dietary behavior among children [156]. In paper I, the diets of the parents and their children were very much alike, suggesting an impact of role modelling, whereas previous studies had reported weak to moderate dietary similarity [35]. In addition, the results of paper I showed a reporter-bias resulting in stronger parent-child resemblance with the parent providing food consumption data on behalf of the child compared to the other parent. Thus, this study did not support the findings of previous studies showing a stronger mother-child resemblance compared to father-child resemblance [36, 38, 139, 157].

Based on the results of this study, the fathers are not to be ignored anymore. It has, in fact, been shown that fathers might be able to report their children's energy intake more accurately than the mothers [127]. However, this finding is still to be confirmed by other studies. Since fathers are, at least in many societies, increasingly involved in family life and child care, they should also be more and more engaged in family-based studies, projects and campaigns. In addition, since children may live in two homes, the time spent with both of the families should be taken into account. In the future, researchers should clearly report who provided food consumption data and take this into account in subsequent analyses. When child self-report is not possible due to age of the participants, researchers should consider the use of two informants, as suggested by Morgan et al. [158].

In addition to the social food environment, the physical home food environment also plays a role. Evidence suggesting that home availability or accessibility is associated with consumption of fruits and vegetables is consistent [30]. However, only a handful of studies have investigated these associations among preschool-aged children [68, 91]. Moreover, the results obtained in papers II and III support the inclusion of unhealthy as well as healthy home food availabilities simultaneously in the models. In other words, healthy and unhealthy home food availabilities are not two sides of the same coin, but different aspects of home food environment. The use of novel whole-diet methods that are able to capture the actual diets of people should be encouraged.

Researchers should also be encouraged to incorporate both physical and social home food environmental factors in their models. Since most children spend a considerable part of their time in preschools and schools, the role of early educators and teachers as role models and gatekeepers should be further investigated. Other significant adults, such as grandparents, should also be taken into account. The impact of peers on food behavior even in small children is another topic worth studying. In other words, a wider definition of food environment should be applied, and the physical food environment should be extended to cover a broader range of places (for example recreational sites and neighborhoods) instead of focusing on home, preschool and school. Finally, the creation of uniform, valid and reliable tools to assess social and physical home food environments would benefit the research considerably.

# 7 CONCLUSIONS

This study showed that parent-child dietary resemblance was relatively strong, suggesting that health promotion programs aiming at improving the diets of the children should target the parents as well. Since the number of shared meals was positively associated with mother-child dietary resemblance, the parents should be encouraged to eat together as a family as often as possible, and simultaneously act as role models for healthy eating. Additionally, since father-child resemblance did not differ from mother-child resemblance after adjusting for the person providing food consumption data on behalf of the child, the role of fathers as a role model in the families should be acknowledged and taken into account when designing family studies on food behavior. An important finding was that parental education was not associated with parent-child dietary resemblance. This information can be made use of in planning health promotion campaigns in families of different socio-economic backgrounds.

In this study, no association between school food availability and dietary behavior among children was observed. This might be explained by methodological reasons. However, the role of home food availability was undisputed. School-aged children are less dependent on their parents in terms of food behavior. Nevertheless, the home food availability was similarly associated with dietary patterns among children of different ages. Based on the results of this study, it seems that it is not enough to have healthy foods, such as fruits and vegetables available in the home – the availability of unhealthy foods may have an even larger role. Thus, parents should restrict the availability of unhealthy foods in the home, in other words, apply covert control.

In summary, this study showed that home food environment, both social and physical, is associated with dietary behavior in children. A general conclusion is that in order to promote healthy eating among children, both parents need to be engaged. The parents have the opportunity to modify food availability in the home, and in addition, to act as role models regarding healthy eating and eating patterns. The knowledge added by this study can be used in planning and carrying out health promoting campaigns in families and schools.

# ACKNOWLEDGEMENTS

I have never been much of a theory-lover, but I must admit that during the past few years I have grown fond of the socioecologic model. As the model states, it is not all about the individual. A talented individual can be crushed by unfavorable circumstances, whereas a mediocrely skillful individual can thrive in propitious conditions. The environments around us – from the closest people to the structures of the society – affect us, often much more profoundly than we acknowledge. Thus, although presented here as my personal achievement, this PhD thesis actually is a result of beneficial circumstances, in which I have managed to perform sufficiently well.

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# APPENDICES

## Appendix 1. The DAGIS FFQ (papers I and II)

**Please try to recall your child's diet over the past week.** How many times has your child eaten the following foods at home or in places other than the nursery? For each food group, record how many times your child has consumed that particular food.

- Use either the "Times per week" or the "Times per day" –column depending on which one, in your opinion, is more relevant.
- Put a tick in the column headed "Not at all" in case your child has not eaten the food in question during the past week.
- In this study, we are only interested in certain foods. The foods that are not included in the table do not need to be recorded. Foods consumed at the nursery are not recorded.
- ***An example:*** The child has eaten plain quark with added frozen blueberries, honey and muesli. The quark is recorded in the row "Plain yogurt , fermented curdled milk products (viili) and quark", blueberries in the row "Berries", honey in the row "Added sugar, honey or syrup" and muesli in the row "Sweetened cereals and mueslis".

**Fill in only one column per row!**

| | **Not at all** | **Times per week** | **Times per day** |
|---|---|---|---|
| ***E.g. Canned and frozen fruit-*** | | ***1*** | |
| ***E.g. 1% fat milk, semi-skimmed milk and sour milk*** | | | ***2*** |
| **VEGETABLES, FRUIT AND BERRIES** | | | |
| Fresh vegetables (e.g. salad, grated carrot, tomato, cucumber) | | | |
| Cooked and canned vegetables (as a side dish or as an ingredient in a dish e.g. mushrooms) | | | |
| Potato (in all its forms) | | | |
| Peas, beans, lentils and soya (e.g. tofu, falafel, chickpeas, seitan, hummus) | | | |
| Fresh fruit | | | |
| Canned and frozen fruit | | | |
| Berries (fresh and frozen) | | | |
| Dried fruit and berries (e.g. raisins) | | | |
| Commercial baby foods and smoothies (**no** added sugar, e.g. Piltti, Froosh) | | | |
| Berry and fruit fools and thickened soups (**with** added sugar) | | | |

| | | | |
|---|---|---|---|
| **DAIRY PRODUCTS** | | | |
| Skimmed milk and sour milk | | | |
| 1% fat milk, semi-skimmed milk and sour milk | | | |
| Whole milk and sour milk | | | |
| Low-fat cheese (less than 20% fat, e.g. Polar 15, cottage cheese) | | | |
| High-fat cheese (20% or more fat, e.g. Oltermanni, Arla Emmental Sinileima, feta cheese) | | | |
| Flavored and sweetened milk- and plant-based drinks (e.g. chocomilk, soya milk) | | | |
| Natural yogurt, "viili" and quark (also the plant-based products, e.g. Luonto+, Alpro Soya) | | | |
| Flavored yogurt, "viili" and quark (also the plant-based products, e.g. Valiojogurtti, Yosa) | | | |
| Puddings (e.g. Jacky-makupala, Risifrutti, Alpro Soya -pudding) | | | |
| Ice cream (e.g. Pingviini, Tofuline) | | | |
| **FISH** | | | |
| Fish dishes and fish products (e.g. fish soup, fried fish, tuna) | | | |
| **MEAT AND EGGS** | | | |
| Red meat (beef, pork, lamb and mutton, game, e.g. meatballs) | | | |
| White meat (poultry, e.g. turkey gravy, chicken stir-fry) | | | |
| Cold cuts (e.g. corned beef, smoked ham, turkey fillet) | | | |
| Sausages, frankfurters and luncheon meats (e.g. pastrami, bologna, lauantaimakkara) | | | |
| Egg (**plain**, e.g. fried, boiled, omelette) | | | |
| **CEREAL PRODUCTS** | | | |
| Brown rice and pasta | | | |
| White rice and pasta | | | |
| Rye bread, crispbread and thin rye crackers (hapankorppu) | | | |
| White wholemeal bread (e.g. multigrain bread, wholemeal rolls, fibre-rich oatbread) | | | |
| White bread (e.g. French bread, white toast) | | | |
| Sugar-sweetened cereals and muesli (e.g. honey frosted or chocolate cereals, mueslis) | | | |
| Berry, fruit and chocolate porridge (**with** added sugar) | | | |
| Wholegrain porridge and cereals (**no** added sugar, e.g. oatmeal porridge, Weetabix) | | | |
| Sweet biscuits and cereal bars | | | |

| | | | |
|---|---|---|---|
| Cakes, cupcakes, sweet rolls, Danish pastries, pies and other sweet pastries | | | |
| **DRINKS** | | | |
| Sugar-sweetened juice drinks (e.g. juice cartons with straw, fruit and/or berry punch) | | | |
| Fruit juice (**no** added sugar) | | | |
| Soft drinks (with added sugar, e.g. Coca-Cola, Jaffa) | | | |
| Reduced sugar juices and soft drinks (e.g. diet sodas, stevia-sweetened drinks) | | | |
| **OTHERS** | | | |
| Chocolate (e.g. chocolate-covered raisins, pralines, milk chocolate) | | | |
| Sweets (e.g. liquorice or fruit drops, pick'n'mix sweets, lollipops) | | | |
| Added sugar, honey or syrup (e.g. in porridge, tea, berries, yo-gurt or quark) | | | |
| Jams, marmalades and sweetened spreads (e.g. Nutella) | | | |
| Plain nuts, almonds and seeds | | | |
| Flavored nuts, almonds and seeds (e.g. salted nuts) | | | |
| Crisps and popcorn (e.g. potato crisps, nacho crisps or tortilla chips) | | | |

## Appendix 2. The ISCOLE FFQ (paper III)

How many times do you usually eat . . . ? (Please mark only one box for each line)

| | Never | Less than once a week | Once a week | 2-4 days a week | 5-6 days a week | Once a day, every day | Every day, more than once |
|---|---|---|---|---|---|---|---|
| Fruits | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Vegetables | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Sweets (candy/chocolate) | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Regular cola or soft drinks that contain sugar | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Cake, pastries, or donuts | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Diet cola or diet soft drinks | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Potato chips | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| French fries | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Dark green vegetables (broccoli, spinach, etc.) | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Orange vegetables (carrots, squash, sweet potato, etc.) | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Fruit juice | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Low fat milk (1%,2%, skim) | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Whole milk (homogenized) | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Cheese | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Other milk products (yogurt, chocolate milk, pudding, etc.) | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Whole grain bread or cereal (oatmeal, muesli, etc.) | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Meat alternatives (beans, lentils, tofu, eggs, peanut butter, etc.) | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Energy drinks (Red Bull, Rock Star, Guru, etc.) | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Sports drinks (Gatorade, Powerade, etc.) | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Fish | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Ice cream | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Fried food such as chicken wings, chicken fingers, etc. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Fast foods such as pizza, hamburgers, etc. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |

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